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A
DISSERTATION
ON THE
KNOWLEDGE
OF THE
ANCIENTS,
IN

ASTRONOMY and OPTICAL INSTRUMENTS;
ON THE
PHYSICAL CAUSES

OF THE
EARTH'S DIURNAL and ANNUAL
MOTIONS;

ON THE
Distances of the PLANETS from the SUN,
and on its Magnitude.

Wherein is demonstrated, that the Composition of a
projectile and gravitating Force, cannot account
for the Motions of the PLANETS; and that their
Distances, and the Magnitude of the SUN, cannot
be by much so great as generally esteemed.

By J. ROGERS, M. D.

— *Si quid tibi forte repertum
Pluribus indiciis sollers fulcire memento.*

ARATUS AVIENI, sub finem.

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M. DCC. LV.

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THE HISTORY OF THE

CHURCH OF ENGLAND

FROM THE REFORMATION

TO THE PRESENT

DISSEMINATION

OF THE GOSPEL

IN THE AMERICAN

UNITED STATES

OF AMERICA

OF AMERICA

OF AMERICA

OF AMERICA

OF AMERICA

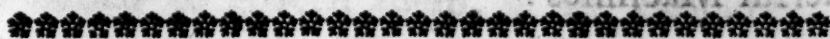
OF AMERICA



DISSERTATION

ON THE

Knowledge of the *Ancients*, &c.



The INTRODUCTION.

THE more we consider the Works of Almighty God, the more Wisdom, Power, and Goodness we discover therein; these Discoveries must raise in us the highest Reverence and Gratitude for our being distinguished from the rest of his Creatures by a Capacity of making them, and contemplating him,
B and

2 The INTRODUCTION.

and of Course make us better Men, and better Christians.

Let us leave to *Mahomet's* unphilosophising Followers the Enjoyment of a sensual Paradise, and find Happiness in discovering and intimately viewing this great and glorious Frame of Nature. What is it to enjoy the God, but to be admitted into the Secrets and Reasons of his mighty Works? The Pleasures of Heaven must be undoubtedly mental; and what can transcend that of knowing the Laws our Maker has appointed to regulate his wonderful Machines?

This is a Study his Goodness has implanted in our Nature for our Benefit; it is the Exercise of our Reason: We are not apt to consider the Plowman, the Smith, and Cook, as Philosophers and Physicians, though really they are so. By Study, and Experiments judiciously made, Men found out the Properties of Seeds, and Roots, which is the Foundation of Agriculture, and the Means of performing it; as Spades, Plows, &c. was owing
to

The INTRODUCTION. 3

to their having explored the Nature of Minerals, that Ore might be refined into Iron, and wrought for the above, and many other valuable Purposes : The Cook too by various Methods has made many Vegetables wholesome and pleasant, that were neither, before they came under his Hands : And did he not generally half digest our Food, we should not enjoy the Health we are now blest with.

To discover therefore, upon what Principles this Earth we inhabit, performs all its Motions, and what Rules the Creator has established to govern them, is an Employment becoming the Dignity of a Man, and a Philosopher, and to him each Discovery is a kind of Anticipation of Heaven, a Foretaste of the Satisfaction he may enjoy in a happy Futurity.

And we see that Speculations of this Sort have employed the Leisure of the greatest Men of all Nations from the earliest Antiquity.

C H A P. I.
Opinions of the Hebrews concerning Astronomy.

ABRAMHAM, we are told by Josephus *,
argued the Unity and Power of God from
the orderly Course of Things both at Sea and Land,
in their Times and Seasons, and from his Observa-
tions upon the Motions and Influences of the Sun,
Moon, and Stars; and that he read † Lectures
to the Egyptians in Astronomy and Arithmetic.

And again, from Benofus ‡. That he was a
great and just Man, and famous for his Celestial
Observations, the making of which, these
Sages thought so necessary to the human
Welfare, that they assign it as the principal
Cause of the Almighty's prolonging the Life
of Man. For the same Author giving an
Account of the Longevity of the Antedilu-
vians, says ||, That Providence found it neces-
sary for the Study and Advancement of Virtue,
and for the Improvement of Geometry and Astro-
nomy, which required at least six hundred Years
for the making and perfecting of Observations.

Moses

* L'Estrange's Josephus, Book I. chap. 8.
† Ibid. chap. 8. || Lib. I. chap. 4.

† Ibid. chap. 9.

Moses was skill'd in all the Learning of the Egyptians, of which Astronomy made a considerable Part, and looked upon Knowledge in the Arts, in Minerals, and precious Stones as the immediate Gift of God, as the Infusion of his Spirit *. *The Lord hath filled him with the Spirit of God in Wisdom and Understanding, and in Knowledge, and in all Manner of Workmanship, and to devise curious Works to work in Gold and Silver, and in Brass, and in cutting of Stones to set.*

David frequently inculcates Philosophy as a religious Duty †. *The Works of the Lord are great, sought out (or diligently inquired into, Perquisita) by all those that take pleasure therein ‡. I will consider thy Heavens, even the Works of thy Fingers; the Moon and the Stars which thou hast ordained ||. I will speak of all thy marvelous Works, &c. §. Job has mentioned the Pleiades and Orion, with his remarkable Belt or Band, Mazzaroth and Arcturus.*

* Exod. chap. xxxv. ver. 31, 32.

† Psal. iii. 2.

‡ Psal. viii. 3.

|| Psal. ix. 1.

§ Job chap. xxxviii. ver. 31.

C H A P. II.

The Antiquity of Astronomy among the Egyptians, Chaldeans, and Babylonians.

THE Egyptians have always been remarkable for their Skill in Astronomy*. It is observed in Tully, That they have cultivated this Science for a prodigious Length of Time, for almost innumerable Ages; and when Herodotus travelled there, pretended to Records for Eleven thousand three hundred and forty Years, or Three hundred and forty-one Generations, or regular Descents from Father to Son in the same Family, reckoning one hundred Years for three Generations†: And that within that time the Sun had twice rose where it now sets, and twice set where it now rises, and

* Tull. Edit. Aldi, Fol. Vol. IX. p. 93. *De Divinat. Lib. i.* Eandem artem (observationem siderum) etiam *Aegyptii* longinquitate temporum innumerabilibus pene sæculis consecuti putantur.

† Herodotus in *Euterp.* Edit. Gryphii, Hershbachii interprete, p. 230. Sed intra hoc tempus quater solem præter consuetudinem fuisse ortum, bis quidem illinc exortum ubi nunc occidit: bis autem ubi nunc oritur illic occidisse: nec tamen sub hæc aliquid in *Aegypto* esse immutatum, non ea quæ à flumine ipsis proveniunt, non ea quæ circa morbos, aut quæ circa mortes eveniunt.

and yet Egypt had felt no Alteration, neither with regard to its River, its Diseases or Deaths.

As there can be but two Places on the Earth, and those exactly under the Line, whose Meridians would not be altered by a Revolution of the Poles, and Egypt, how luckily soever situated in regard to the said Places, lying between 21 and 31 Degrees of North Latitude, must have been both under the Line, and at least as much South: It must successively have changed all the Cardinal Points, and if both it and its River were not lost by the Increase of the Earth's Bulk, under the Line from the diurnal Motion, the Face of the Country must be much altered by the great Equatorial Rains, compared with its present Drowth. This, I say, makes the whole Story more suspicious; but whether he misunderstood the *Egyptian* Priest, from whom he had the Account, or whether the Relater's Vanity prompted him to exaggerate the Knowledge and Antiquity of his Country, we are at a Loss to determine, having scarce any thing left of the antient *Egyptian* History.

8 *The Antiquity of Astronomy among the*

And this Tradition of the very great Antiquity of Astronomical Records seems to have been received by most of those we now call Antients, though variously related; it is observed in Tully *, *That the Babylonians had monumental Records for Four hundred and seventy thousand Years.*

And Pliny † giving an Account of the Inventers of Letters, relates from Epigines, whom he accounts a very solid and valuable Author, *that the Babylonians had Observations of the Stars inscribed on burnt Tiles for Seven hundred and twenty, and from Berofus and Critodemus for Four hundred and eighty of Years, where (Thousands) must be understood to make it Latin or Sense, because he* infers

* *De Divin.* Vol. IX. pag. 101. Contemnamus etiam Babylonios, & eos qui ex Caucaso cæli signa servantes numeris & motibus stellarum cursus prosequuntur; condemne-
mus inquam hos, aut stultitiæ, aut vanitatis, aut imprudentiæ, qui CCCCLXX. millia annorum ut ipsi dicunt monumentis comprehensa continent.

† *Nat. Hist.* Lib. VII. cap. 56. Epigines apud Babylonios DCCXX. annorum observationes siderum, costilibus laterculis inscriptas docet gravis autor imprimis: qui minimum Berofus & Critodemus CCCCLXXX. annorum, ex quo apparet æternus literarum usus.

Egyptians, Chaldeans and Babylonians. 9

infers from these Monuments, that the Use of Letters must be eternal.

The latter Part of this Account agrees pretty well with the abovementioned Observation in Tully, as does *Diodorus Siculus* *, who in his Account of the Chaldeans, observes, That they are the most ancient People of Babylonia, and that as the Priests in Egypt, so they in their own Republic are set apart for the Worship of God, and apply themselves to Philosophy through their whole Lives; and that the Children through all Generations follow the Profession of their Fathers, the Care of all other Matters set aside; so that they being initiated in

* Lib. II. cap. 8. Translationis à Castiglione, folio, Basl. 1559. Chaldei, Babyloniorum antiquissimi, eum locum in sua republica quem in Aegypto sacerdotes obtinere, ad cultum enim Deorum deputati, per omnem vitam philosophantur, non enim quemadmodum Græci horum omnium doctrinam percipiunt: nam pueri à patribus progeniem secuti eam discunt philosophiam omni, aliarum rerum posthabita cura. Ita tum quia teneris annis in ea doctrina erudiuntur, tum quia diutius in illa perseverant, doctissimi evadunt: apud Græcos ut plurimum tarde ad philosophiam accedunt paulumque in ea immorati ad quæstum vertuntur,—non enim de more imitantur parentum doctrinam,—numerum annorum quibus se hujusmodi doctrina vacasse affirmant haud facile quis crediderit; nam quadringenta tria annorum millia annumerant usque ad Alexandri ascensum ex quo astrorum observationes ab se captas dicunt.

10 *The Antiquity of Astronomy among the*
in their tenderest Years, and persevering all their
Lives, become of all others the most learned;
not like the Greeks, who dip into every Thing,
and not being fixed by the Rules of their Parents,
slowly arrive at Philosophy, and are soon di-
verted from its Study by love of Money and
worldly Interest; so that not relying on any cer-
tain Principles, their Minds fluctuate in con-
tinual Doubt and Uncertainty. And that these
Chaldeans in particular have applied themselves
to Astronomy for Four hundred and three thou-
sand Years before Alexander's Entry into Baby-
*lon. Syncellus * has preserved a Fragment of*
Berosus, who wrote the Antiquities of Baby-
lon soon after the Time of Alexander; and
assures us that they preserved with greatest
Care in that City, Commentaries, containing all
that had passed for above One hundred and fifty
thousand Years. † Diogenes Laertius tells us,
That Philosophy had its Rise from the Magi
among the Persians, the Chaldeans among the
Babylonians and Assyrians, and the Druids
among the then reigning Opinions of the

* Syncell. pag. 28. Αναγραφαι δε πολλων εν Βαβυλωνι φιλοσοφικων μετ' πολλης επιμελειας, απο των αυτων μυθων διατυπωται.

† Lib. I. cap. 1.

among the Gauls; and that from the Time it begun to be taught to Alexander the Great, was Forty-eight thousand eight hundred and sixty-three Years, wherein were observed Four hundred and seventy-three Eclipses of the Sun, and Eight hundred and thirty-two of the Moon; but he being so particular about the Eclipses overturns the whole Story; for we observe about Twenty-one Eclipses of the Moon in twenty Years, and seven of the Sun, so considerable as to be seen with the naked Eye; whereas by this Account there is but one of the Sun in One hundred and thirty-one Years, and one of the Moon in fifty-eight Years.

The Egyptians, it is plain, from the before-cited Passage of *Herodotus*, had discovered, or fancied they had, a Decrease of Obliquity in the Poles of the Ecliptic; as such a Discovery would argue a great Accuracy in the Instruments; and Patience, Diligence, and Ingenuity in the Observers; and being agreeable to the then reigning Opinions of the Philosophers *, that the World was eternal; they

* *Aristotle De Caelo*, cap. 12.

they probably invented these extraordinary Æra's in Support of this darling Discovery, a Thing too common among Writers in Physics, who sometimes don't scruple to affirm, they have seen or done what they are once convinced may be seen or done. As not to be tiresome with too many Proofs of so known a Fact: Sir *Thomas Brown*, an ingenious, learned, and religious Man, was so transported with his Analyses of Plants, and Proofs of the Palingenesis or Resurrection, as to affirm *, *That from the Ashes of a Plant he could revive the Plant, and from its Cinders recall it to his Stalks and Leaves again.* This, and more extraordinary Things of this Kind, were in his Time commonly pretended to †. The Mind of Man is not able to comprehend Infinity, and of Course will be staggered at any thing that looks like an Approach thereto, or what in our ordinary Discourse we call an almost infinite Number of Years. These Opinions, therefore, of the Antients, are too foreign to our Way of thinking to expect any Credit, and

* *Brown's Religio Medici*, p. 114.
 Digby on *Vegetation*, p. 72.

† Vid. Sir *Kenelm*

and serve only to convince us of their great Credulity in regard to the Antiquity of Astronomy, or that it was probably the first polite Science cultivated among Men.

The most early authentic Account we have of this Matter, is from *Callisthenes*, a near Kinsman of *Aristotle* *, whom he recommended in his Stead to *Alexander* when he retired to *Athens*; from his Attendance on that Prince he accompanied him in his *Persian Expedition*, being employ'd to record every thing memorable therein †. And when he came to *Babylon*, found there a Series of *Astronomical Observations* for One thousand nine hundred and three Years to that time ‡, of which he sent an Account to *Aristotle*.

The Gravity and Character of this great Man will give Weight to his Relation. He had no Interest to serve, nor Passion to gratify, in magnifying the Antiquity of the *Babylonians*; he

* *Diogen. Laert. Edit. Plantin. à Sambuco tralat. in Vit. Aristotelis.*

† *Justin, Lib. XII. cap. 6.* ‡ *Simplic. De Cælo, Lib. II.*

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he hated the *Persians* for their Flattery of his Prince; his Attachment to Truth occasioned all his Misfortunes, for he alone *, openly declared against paying divine Worship to *Alexander*, which the oldest and greatest of the *Macedonians* beside, dar'd only in Silence to repine at, for which, under the Pretext of *Hermolaus's* Conspiracy, (though all the Conspirators upon the Rack declared him innocent) he had his Legs and Arms † broke, his Ears cut off, his Nose and Lips deformed, and shut up in a Cage, was carried from Place to Place, and at length put to the most cruel Death the Tyrant could contrive. And when in Disgrace so highly was he esteemed, that *Lyfimachus* one of the most illustrious of the *Macedonians* and Successors of *Alexander*, at the hazard of his Life went to listen to and receive from him the Precepts of Virtue.

The learned *Aldus* in his Commentary on that *Tusculane* Question ‡, where *Tully* mentions *Theophrastus's* Book, deploring the Death
of

* *Plutarc. in Vit. Alexand.* † *Justin. Lib. XV. cap. 3.*

‡ *Tull. Oper. Tom. VIII. Lib. iii. p. 196.*

Egyptians, Chaldeans and Babylonians. 15

of his Friend *Callisthenes*, observes, that this was *Alexander's* indelible Crime, which no Virtue, no Success in War can atone for, and which lost him the Hearts of the *Grecians* more than any other Action*.

I have dwelt the longer on this Story, because it tallies very well with the *Mosaic Account* of the Flood and Tower of *Babel*: Making these Observations †, as *Dr. Prideaux* has observed, commence One hundred and fifteen Years after *Noah's* Flood, and fifteen after the building of the Tower, which is as soon as their Instruments could be presumed to be got ready, supposing with *Bochartus* and other learned Men, that the Tower of *Babel* of the Scriptures, and the Temple of *Belus* in *Babylon*, with the Observatory at Top, as mentioned by *Strabo*, *Herodotus*, *Diodorus Siculus*, and *Arian*, were both one.

But tho' we have these surprising Histories of the Antiquity, we have no Traces of the
Astro-

* *Quint. Curt. Lib. VIII. cap. 8.*
Book II. p. 100.

† *Prideaux's Connec.*

Astronomy of these Eastern Sages; so much more fond is the World of the Marvelous than the Useful; there are preserved many Accounts of this kind that amaze, few that instruct Mankind: We know nothing of their Opinions of the Sun, Planets, Comets, fixed Stars, &c. nor what kind of System they embraced, though the Eastern Libraries were exceedingly stock'd * with Books; the *Pergamian* alone, which *Mark Anthony* brought away and gave *Cleopatra*, contained two hundred thousand Volumes; of which, doubtless, many explained the Principles of their Philosophy and Astronomy; particularly *Berosus*, to whom, for his Excellency in that Science, the † *Athenians* erected a Statue in their public Schools with the Tongue gilt.

* *Plutarch. in Vit. M. Anton.*
Lib. VII. cap. 37.

† *Plin. Nat. Hist.*

C H A P. III.

Astronomy of the Greeks and Romans.

AS for *Ptolomy* the Astronomer, though born in *Egypt*, he may be reckoned a *Greek*, and unacquainted with the ancient *Egyptian* Learning; and as he lived in the *Antonine's* Time, about one hundred and forty Years after Christ, was too late to know much of the *Pythagorean* Philosophy; for *Cicero* * *complains that in his Time, two hundred Years sooner, the Learning of the Pythagoreans, which had flourished some Ages in Italy and Sicily, was some how lost*; and it is extremely probable, that had this great Man ever seen the *Pythagorean* heliocentric System, he had saved himself much Labour, which the finding out his Epicycles must have cost him; and have laid out his great Wit and Industry, in improving a Science he was in a great Measure obliged to be the Inventer of.

Nor do I find that any of the ancient Romans attempted to account for the Phenomena

* *Tull. de Universit. sub initium.* Post illos nobiles Pythagoreos quorum disciplina extincta est, quodammodo cum aliquot sæcula in Italia Siciliaque viguisset.

mena of the Planets, though they very well * understood the Times of their Revolutions, and Places in the Heavens; the Zodiac, Constellations, and Progreſſion of the Equinoxes, or Annus Magnus. They were generally too much employ'd in Conquest, and enlarging their Boundaries, to attend much to this Science; yet they had some great Men famed for their Skill in Astronomy and Geometry, as *P. Nigidius* †, *C. Sulpicius Gallus*, and *S. Pompeius* ‡; and the great *Julius* found Leisure from the Temple, the Bar, and the Camp, to attend to Astronomy and settle the Kalendar: And if he was so little exact therein to need the Gregorian Amendment, it must have been owing to his not thinking it worth while to take notice of a Deficiency of eleven Minutes in a Year, especially as it broke into his round Number of six Hours, and intercalary Day every four Years, that Deficiency being commonly known in his Time; as his contemporary *Tully* || observes, that the Sun finishes his Circuit

* *Tull. de Universit. & in Somnio Scipion.* † *Ibid. de Universitat.* ‡ *Id. de Offic.* || *Id. de Nat. Deor. Circuitus enim solis orbium quinque diebus LX. & CCC. quartæ fere diei parte additâ conversionem conficiunt annum.*

cuit in three hundred and fixty-five Days, and *almost* six Hours.

As the *Greeks* were a much more ancient People than the *Romans*, the politer Arts were brought to Perfection among them before the latter had founded their City, or secured a Territory able to supply their Colony with the Necessaries of Life. *Orpheus*, *Musæus*, *Homer*, *Hesiod*, wrote many hundred Years before *Ennius**, who was their first Poet of any Note, *Lucretius*, *Virgil*, *Horace*.

Phidias, *Zeuxis*, *Praxiteles*, *Apelles*, had brought Painting and Statuary to Perfection before the first Punic War †, before the *Romans* had made any Noise or Figure in the World ; and their Mathematics and Astronomy are more ancient still, the Zodiac and Constellations, especially the North-

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ern

* *Ennius ut noster cecinit qui primus amœno
Detulit ex helicone peremni frunde coronam.*

LUCRET. Lib. I.

† *Plutarch. in Vit. Marcell. à Guarino. Marcellus — Pulcherrima ac plurima Syracusis signa detraxit — ad urbis ornamentum, nondum in ea gratiosa hæc & amabilis sculptura penetraverat.*

ern Ones, as we now have them, having been settled an Age or two before the Trojan War, about the Time of the *Argo-nautic Expedition*; for the principal Persons and Things relating thereto, are depicted in the Asterisms*; yet, whether from the overturning the several Grecian Republics, the breaking the Kingdom of *Macedon* by *Alexander's Death*, or the *Roman Conquests* in *Greece*, we know little of their Astronomy, but such Scraps as we can pick up from Authors, who wrote many hundred Years after. And as *Pythagoras* seems to have been the best of their Astronomers, such Things as we can collect relating to his Knowledge, may give us the best Insight therein: He lived about the fifty-second Olympiad, or five hundred and sixty-nine Years before the Christian *Æra* †.

* Sir *Isaac Newton's* Chronology, p. 84.

† *Dodwell de Ætate Pythagoræ*, p. 93.

CHAP. IV.

The Pythagorean Astronomy.

Jamblicus, who wrote *Pythagoras's Life*, about A.D. 193* ; having taken notice of the extraordinary Beauty of his Person, adds, *That Religion, Learning, and a careful Exactness in what belonged to the Body; a Firmness of Mind, and settled Modesty, adorned him; in his Words and Actions, appeared internal, quiet, and immutable Tranquility; he never gave way to Anger, Laughter, Emulation, Strife, or any Perturbation of Mind; so that he seemed among the Samians, superior to Humanity* †.

Pherecides, a Syran, who first taught the Immortality of the Soul ‡, was his Master ||; he with Thales advised his going into Egypt, to study under the Priests of Memphis §, and he was initiated into all their Mysteries ¶; not out of Superstition, (says my Author) as some weak People may imagine, but from a love of Contemplation

C 3

* Jamblic. Edit. Kuster, 1707. p. 7. † Δεινὸν τὸ αἰσῶδες
 εὐκταῖον τὸν ἄνθρωπον. ‡ Tull. Disputat. Tuscul. p. 145. || Id.
 De Divinat. p. 117. § Jamblic. in Vit. cap. ii. p. 9.
 ¶ Ibid. cap. iii. p. 11.

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*temptation, and Fear lest he should miss any Thing worthy being known: This Initiation, Porphyry observes *, was an Honour not before granted to any Foreigner. Having spent two-and-twenty Years in Egypt, in the Study of Geometry and other Arts †, he was carried by a Soldier of Cambyfes to Babylon, where he spent twelve Years more, and then returned to Samos, his native Country, and begun to teach Philosophy, as he had learned it in Egypt, by Symbols or Enigmas; for which Method the Samians having no Taste, he removed into Italy ‡, which, though before thought scarce worthy of Notice, was purely on his Account called || Magna Græcia.*

It is on the Foundation of this great Man, that we have built all our present noble Astronomy, to which are owing those Advantages of Trade we enjoy from our Navigation, and the Discovery of many rich and extensive Kingdoms,

* *Porphyr. in Vit. Pythagor. p. 12.* † *Jamblic. p. 15.*
 † *Ibid. p. 27.* || *Tull. Tuscul. Disputat. p. 243. Pythagoras—qui—cum in Italiam venisset, exornavit eam Græciam quæ Magna dicta est. Et Jamblic. p. 141. Την Ιταλίαν πασαν Φιλοσοφῶν ἀνδρῶν ἐμπλησθῆναι καὶ πρῶτον αἰσθημένης αὐτῆς ὑπερὶν διὰ Πυθαγόραν μέγαλην Ἑλλάδα κληθῆναι.*

doms, as much unknown to our Ancestors, as those of the Moon or Planets are to us.

*He first taught that the Earth was round and globular, inhabited on every Side * ; that it moves in an Orbit round the Sun †, as do likewise the other Planets ‡; that the Variety of the Seasons was owing to the Obliquity of the Zodiac, thro' which the Sun passes from Tropic to Tropic ||; that the Vicissitude of Day and Night, is owing to the diurnal Motion of the Earth §; that the Sun may be reckoned among the fixed Stars ¶; that the Stars were globular Bodies, like the Sun, Moon, and Earth **, and at different Distances ††; that every Star was a World, sur-*

C 4

rounded

* Diogen. Laert. Sambuc. in Vit. Pythag. Terram rotundam esse & globosam & circum habitari, esse autem Antipodas nobis adversa vestigia premere.

† Την δε γην κινει περι του 'Ηλιακου κυκλου. Plutarch de Placitis Philosoph. Βιβλ. β. κεφ. κδ.

‡ Ibid. κεφ. ιε. Τινες δε μεσον παντων τον 'Ηλιον.

|| Περι την λοξωσιν του ζωδιακου κυκλου δι ου φερεται λοξοιερων ο 'Ηλιος, κ' καλα δορυφοριαν των τροπικων κυκλων. Ibid. κεφ. κγ.

§ Cicero de Universitate, p. 224. Jam vero terram alticem nostram quæ trajecto axe sustinetur diei noctisque effectricem.

¶ Αρισταρχος τον 'Ηλιον ιστησι μελα των απλανων. Βιβλ. β. κεφ. κδ. Plutarch. de Placit.

** Ibid. κεφ. ιδ. 'Οι φυσικοι σφαιρικας τας αστερας καταπερ τον κοσμον κ' 'Ηλιον κ' σεληνην.

†† Ibid. κεφ. ις. Περι των ετερων τας ετερας εν υψει κ' βαθει.

rounded by its Earth, Air, and Æther in the infinite Space * : And again, That every particular Star made a World † ; that the Eclipses of the Moon came from her running into the Earth's Shadow, and of the Earth from its entering the Moon's ‡ ; that the Moon was composed of the same kind of Matter as our Earth, and like it inhabited; but by Animals fifteen Times larger, from its Days being so much longer than ours || ; that it had Plains, Hills, and Valleys § ; that it was illuminated by the Sun ¶ ; that it was distant from the Earth seven hundred and eighty thousand Stadia, or ninety-seven thousand five hundred Miles, and eighteen Times further from the Sun ** ; that the Comets are of the Number of those Stars that do not continually appear in the Heavens; but which at stated Times, having finished a certain Circuit,

* Οἱ Πυθαγόρειοι ἑκάστον τῶν ἀστέρων κόσμον ὑπαρχεῖν γῆν περιεχάνια αἶρα τε καὶ αἰθέρα ἐν τῷ ἀπειρῷ αἰθέρι. Ibid. c. 13.

† Ibid. Κοσμοποιῶσι δὲ ἕκαστον τῶν ἀστέρων.

‡ Ibid. Κεφ. κθ. Τὰς δὲ ἐκλείψεις εἰς τὸ σκίασμα τῆς γῆς εἰσπίπτουσιν μετὰ ἀμφοτέρων τῶν ἀστέρων γινομένης μᾶλλον δὲ τῆς σελήνης ἀνιφραττομένης.

|| Ibid. Κεφ. λ. § Ibid. Κεφ. κε. Σίρηνμα δὲ ἀπύρον ἔχον ἐν ἑαυτῷ πεδία καὶ ὄρη καὶ φαραγγας.

¶ Ibid. Κεφ. κη. Ὑπο τῇ Ἥλῳ φωτίζεται τὴν σελήνην.

** Ibid. Κεφ. λα. Οἱ ἀπὸ τῶν μαθηματικῶν οὐλῶν καὶ δεκά πλάστων Ἐρατοσθένους τὸν Ἥλιον ἀπέχειν τῆς γῆς σταδίων μυριάδας ἑβδομηκοντά οὐλῶν.

Circuit, use to arise a-new*; that the whiteness of the milky Way, was owing to the Light of a vast Number of small Stars, close set, and shining therein†: He too, first discovered the Nature of Venus, viz. That Vesperus, or the Evening Star, and Phosphorus, or the Morning, were one and the same‡; and this was look'd upon as so great a Discovery, that the time it was made is recorded by Pliny||; he allowed a Vacuum§, and that Matter was divisible in Infinitum¶, and the Gravity of Matter; and that the Planets were kept in their

* Των απο Πυθαγορον τινες μην αστερα φασιν ειναι την κομητην, των τε αει φαινομενων, διαλινθ. δε ωρισμενε χρονον περιδικως αναελλοιων. Ibid. Lib. III. cap. ii.

† Πολλων η μικρων η συνεχων αστερων συμφωλιζομενων. Ibid. κεφ. α. βε. γ. & Aristotel. Meteorol. Lib. I. cap. viii. Perionio interprete. Paris 1580. Anaxagoras autem & Democritus Lac quarundam stellarum lumen esse dicunt.

‡ Diog. Laert. in Vit. Pythagor. Primum item vesperum atque luciferum idem sydus dixisse autore Parmenide.

|| Plin. Nat. Hist. Lib. II. cap. viii. Quam naturam ejus (scil. Veneris) Pythagoras Samius primus deprehendit, Olympiade circiter quadragesima secunda, qui fuit urbis Romæ annus centesimus quadragesimus secundus.

§ Plut. de Placitis, Lib. I. cap. xviii. Τα μεν ατομα απειρα τω πλεθει, το δε κινον απειρον τω μεθεει.

¶ Ibid. cap. xvi. Οι απο βαλεω η Πυθαγορε παδηλα σωματα η πηλητα εις απειρον.

their Orbits by Gravitation, as may be collected from *Jamblicus* * and *Pliny* †.

I have not scrupled to ascribe some few Things to *Pythagoras*, that are by *Plutarch* and *Diogenes Laertius*, &c. said to come from other Philosophers; but then they are only such Things as father themselves, such Things as evidently belong to the *Heliocentric Pythagorean Scheme*. *Tully* observes ‡, *That there might, among the Romans, be traced out a great many Footsteps of the Pythagoreans*; and that *Plato* went into *Italy* on purpose to make himself acquainted with them, and from *Archytas* and *Timeeus*, learned their *Philosophy* ||. *The ancient Pythagorean Philosophy,*

* *Jamblic. in Vit. Kεφ. ιι.*

† *Plin. Nat. Hist. Lib. II. cap. xxii. and Maclaurin on Sir Isaac Newton's Discoveries, p. 32.*

‡ *Tull. Vol. VIII. p. 214. Vestigia autem Pythagoreorum quamquam multa colligi possunt. Ibid. p. 145. Platonem ferunt ut Pythagoreos cognosceret in Italiam venisse, & in ea cum alios multos tum Architam Timæumque cognovisse & didicisse Pythagorea omnia.*

|| *Porphyrus in Vit. Pyth. Sect. 53. Και δια ταυτην πρωτην εσαν την Φιλοσοφian ταυτην συνεση σβισθηναι. Πρωτον μεν δια το αυτηματωδες. Επειτα δια το κ' τα γεγραμμενα Δωριδι γεγραφδαι. Εχσης τι κ' ασαφης διαλεκτις τω μη αυτηρος Πυθαγοριως ειναι τες εκφερονται ταυτα: πρσ δε τε τοις τον Πλαωνα κ' Αριστολην, Σπευσιππον τε κ' Αριστοξενον κ' Ξενοκρατην ως φασιν οι Πυθαγορειοι τα μεν καρπημα σφειρισσασδαι δια βραχειας επισκευης. Τα δε επιπολαια κ' ελαφρα. Και οσα προς διασκευη κ' χλυσμον τε διδασκαλειν υπο των Βασκανω; υγερων συνόφαντετων προαλλεϊαι συναβαιειν κ' ως ιδια της αιρεσεως καταχωρισαι.*

sophy, says Porphyry, was lost from sundry Causes; first, by being wrapped up in Ænigmas, was not so easily understood: Again, Because they made use of the Doric Dialect, which has a natural Obscurity, especially as they who pretended to explain it were not real Pythagoreans; and it moreover happened, that Plato, Aristotle, Speucippus, Aristoxenes, and Xenocrates, published the most useful and valuable Parts, a little disguised, as their own; and heap'd up whatever they thought was trifling, or tended to render ridiculous or subvert the Pythagorean School, and published such as the Oddities of the Sect.

The Method of explaining by Symbols opens a large Field for Misrepresentation; any one may take the Symbol in a literal or figurative Sense, as he is disposed; the famous Story of Pythagoras *shewing his golden Thigh to Abaris the Hyperborean* *, has been the standing Jest of the Witlings of all Ages by being taken literally; but being explained as a Figure or Symbol, means no more but that

* Diogen. Laert. in Pythag. & Jamblic. p. 77.

that he let his ingenious Friend *Abaris* into all the most concealed Secrets of his Philosophy; and that as the Thigh, which Custom, Prudence and Modesty, obliged him to conceal, was of Gold, or the most valuable Part of his Body; so such concealed Parts of his Philosophy were of the most Worth.

Nothing is more common than to compare any thing valuable to Gold: So the noble *Ethic* Verses of this great Man, published by *Hierocles*, are called ΧΡΥΣΑ, the Golden Ones; so by his having been * *Athalides*, *Pantoides*, *Euphorbus*, *Hermotymus*, and *Pyrrhus*, was meant the Immortality of the Soul, and perhaps its various Purgations; it was he that first brought this Doctrine into Greece †, and confirmed it in Italy ‡, for the Pythagoreans, by firmly persuading their Disciples

* *Diogen. in Vit. p. 2.*

† *Porphyr. in Vit. p. 24, 25.*

Πρόλον μὲν ὡς ἀθάνατον εἶναι φησὶ τὴν ψυχὴν. Φανταίαι γὰρ εἰς τὴν Ἑλλάδα τὰ δόγματα πρὸς ἡμῶν ταῦτα Πυθαγόρας.

‡ *Tull. Tuscul. Disputat. Vol. VIII. p. 145.* Pherecydes Syrus primum dixit animos hominum esse sempiternos.—Hanc opinionem discipulus ejus Pythagoras maxime confirmavit. Ὡς ἢ ἐν φθαρτῇ τὴν ψυχὴν ἀλλὰ διαμένειν τῶν ἀποθανόντων, καὶ ὅτ τὸν θάνατον οὐ φοβήσεται ἀλλὰ πρὸς τῆς κινήσεως εὐρυφῶς ἐκείν. *Jamblic. in Vit. Sect. 173.*

ciples of the Immortality of the Soul, and that it should exist unhurt after the Separation from the Body, taught them to despise Dangers and Death.

The Ancients understood this Doctrine in no other Manner, *Maximus Tyrius* having related * the above Metempsychosis, and two others of the same Sort; *What*, says he, *can be the Meaning of these Stories of Epimenides, Pythagoras, and Aristæas, nothing sure but the retiring of a good Man from Pleasure and bodily Affections, when the Soul freed from their Tumult, looks into itself, and (Appearances apart) contemplates Truth only; so likewise when Beans are forbid to be eat †, is meant that Justice ought not to be corrupted by Money; the Athenians anciently collected the Suffrages of the Judges, whereby the Accused were acquitted or condemned by Beans, which the Ænigma says should not be eat or turned into a Livelihood.*

C H A P.

* *Maxim. Tyr.* Λόγος κη. Τι δη ποτ εν Επιδμενιδες κ' Πυθαγορας κ' Αρισταας εδιδωσαν αιτινισθαι; αλλο τι η την σχολην της ψυχης τε αλαδαν ανδρες απο των τε σωμάτων ηδονων κ' παθημάτων οταν απαλλαξαισα τε περι εκεινο ταραχε κ' επιστρεψασα εις εαυτην τον νεν εμπανιν εισλχανη τω αληθει αυτω εφικμενη των ειδωλων.

† *Vid. Jamblic. p. 209, & Not. 27. ejusdem.*

C H A P. V.

Knowledge of the Ancients in Optical Instruments.

AMONG the many Discoveries of this extraordinary Person, there are some that seem above the reach of the acutest Wit, or deepest Contemplation, unassisted with some mechanical Machine to strengthen or extend the Sight: Without Optical Assistance, how could he imagine that there were Plains, Hills, and Valleys in the Moon, as good Telescopes have demonstrated there are; that the Milk of the Via Lactea was owing to the Light of a Number of Stars, which we call Telescopical, from their being discoverable only with a good Telescope; or that the Morning or Evening Stars were both one, though the former never appears but in the East, the latter only in the West? Nothing but its being manifest to Sense, the different Phases being viewed and judiciously compared could suggest such a Thought.

The same Sagacity that made this Discovery necessarily demonstrates, that the Planet

moves round the Sun, because we see it both to the East and West thereof; the ingenious Dr. Gregory has observed *, *That the Variety of Phases gave occasion to the Inhabitants of the Earth to find out that Venus and Mercury move about the Sun.* Now it must be a very good Telescope that shews distinctly these Phases; and here we may observe, that on the loss of the Instrument wherewith any Discovery has been made, the Discovery itself must likewise be lost, as it can no longer be demonstrated to the Senses, it becomes merely a Report; so the beforementioned remarkable Discovery of *Pythagoras*, that the Morning and Evening Star were both one, was lost even to *Pliny* the Recorder of it, who giving Account of the Variety of Colours of the Planets, again separates them by assigning each a different one †.

There is a Passage in *Jamblicus* that plainly insinuates, some such Instrument was known to

* *Astronomy*, Vol. II. p. 878. † *Plin. Nat. Hist. Lib. II. cap. 18.* Suus quidem cuique color est, Saturno candidus, Jovi clarus, Marti igneus, Lucifero candens, Vesperi refulgens, Mercurio radiaris.

to *Pythagoras*, for giving an Account how he came to find out his Harmonics and their Ratio's; he says *, *As he was most intently studying to find out some Instrument that would be an efficacious and infallible Assistance to the Hearing; as the Ruler and Compasses, or more particularly (Dioptra) Optic Glasses were to the Sight, or Weights and Measures were to the Touch, he passed by a Smith's Shop, &c.*

I must allow that *Dioptra* may be translated, the Sights of any Geometrical, or Astronomical Instrument, as of a Quadrant or Astrolabe, &c. Now as Astronomers are very conversant in Circles and right Lines, the Ruler and Compass are very efficacious and infallible Assistants; without them the Eye would be much fatigued to describe either to any thing like Exactness; but I do not see how the *Dioptra* taken in any other Sense than Optic Glasses, can be so particularly
more

* *Jamb. in Vit. p. 96.* Εν φρονίδι πόλε κ' διαδοσίμω συντέλειμεν
υπαρχών εισαρά δυναίσο τη ακοή βοηθείαν τινα οράνικην επινοήσαι πασίαν κ'
απαρалоίον όαν ή μεν οφθαλμικη δια τε διαβητικη κ' δια τε κανονικη ή ΝΗ
ΔΙΑ δια διοπτρας έχει ή δε αφη δια τε ζυγισ ή δια της των μελων επι-
νοιας. Παρα τι χαλκοιυπειαν, &c.

more infallible and efficacious to Vision than either the Ruler or Compass.

* *Pythagoras*, we are told, *brought to Perfection the Knowledge of the Heavens, demonstrating the whole by Arithmetic and Geometry*; but as this Astronomy was many Ages lost to the World, we cannot wonder that the Instruments used therein were so too, for Reasons already hinted: And because † *their Maxims or Aphorisms, which contained all their Learning, they concealed with utmost Care, as if they had been the Mysteries of the Gods, they committed them solely to the Memory, (not allowing them to be written) and so handed them down to their Successors; whence it happened, that scarce any of their valuable Secrets were ever divulged, tho' taught for a great Number of Years, but always between private Walls; and if it at any Time happened that Strangers*

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were

* *Jamb. in Vit. Pythag.* p. 20. Πυθαγόρας δὲ συνέλεξε τὴν περὶ τῶν οὐρανίων ἐπιστήμην καὶ τὰς ἀποδείξεις αὐτῆς ὅλως ταῖς ἀριθμητικαῖς καὶ ταῖς γεωμετρικαῖς διέλασεν.

† *Ibid.* p. 183. Καὶ ὅτι τὰ κυρίως καὶ συνέκλειστα τῶν ἐν αὐτῇ δογματίων, ἀπορρήτα ἐν ἑαυτοῖς διεφυλακτοῦν ἅπαντες αἱ μέλα ἀκριβὲς ἐχεμυδίας—καὶ ἀγραφῶς ἐν μνήμῃ τοῖς διαδοχοῖς ὥσπερ μυστήρια δεῶν μίλα παραδίδοντες. Διόπερ οὐδὲν ἐξεφοίησε τῶν τε λόγων ἀξίων μετρίᾳ πολλῶν δὲ διδασκομένων—ἐν ὅσῳ τοιχῶν μόνον ἐγνωρίζετο. Ἐπὶ δὲ τῶν θυραίων—καὶ ὥστε τυχοῖ διασυμφορῶν ἀλλήλοις οἱ ἀδελφοὶ ἡντινόητο.

were present, they conversed in Symbols and Enigmas. And so tenacious * were they of these Secrets, that Millias, a Crotoniate, refused to share the Kingdom with the Tyrant Dionysius, preferring to it a cruel Death, rather than discover the Meaning of some of these Enigmas †. And it is indeed surprising, that for so many Ages, no Pythagorean published his Philosophy, till Philolaus, driven to it by extreme Poverty, published the three Books that Dio of Syracuse bought of Plato at ten thousand Attic Drachmas. A prodigious Price, unless they contained Descriptions of something very valuable and uncommon ‡. And this Care of concealing their Sentiments, Cicero testifies in his Book *de Nat. Deorum*.

There is a Passage in *Plutarch* ||, where he gives

* *Jamb. p. 160.* Αλλ ὑμεῖς γὰρ εἰπὲν ὑπὲρ πάντων τῆς ἀξίας ταῦτά σφι παρ' ἐμῇ τιμῇς εἰ μοι συμβασιλεύσαι δειλησέτε, &c.

† Εὐ γὰρ τοσαύταις γενεαῖς ἔχων ὕδαίς ὕδατι φαίνεται τῶν πυθαγορείων υπομνημάτων περίελευχος πρὸ τοῦ φιλολαῦ ἡλικίας. Αλλ' ἔτιος πρῶτον ἐξηγήσατο τὰ δευδόμενα ταῦτα τρία βιβλία ἃ λέγεται Διὶ οὐ Συρακυσίῳ ἑκάστον μὲνων περιεσθαι. *Jamb. p. 165.*

‡ *Tull. De Nat. Deor. p. 19.* Nec tu me celas ut Pythagoras solebat alienos, nec consulto dicis occulte tamquam Heraclitus.

|| Ὅρῳμεν δὴ καλὰ γραμμάς ἢ καλὰ εὐδαιας ἢ καλὰ καμπύλας ἢ κατ' ἀνακλωμένας γραμμάς ἀδελφῆς λογωδευρητῆς καὶ ἀσωματῆς. Καλὰ μὲν ἐν εὐδαιᾷ ὁρῳμεν τὰ ἐν αἰρί καὶ τὰ διὰ τῶν λιθῶν τῶν διαγῶν καὶ κεράτων λεπτομέρη δὲ ταῦτα

gives a kind of Explication of Vision, which I hope may clear up this Affair. *We see Bodies*, says he, *either in right Lines, in bent or crooked ones, or lastly in refracted: Such Things as we see in the Air, or through pellucid Gems or transparent Horn, are by strait Lines; those we see in Water, by reason of the greater Density of the Matter, are by bent ones; wherefore the Oars of a Boat appear bent in the Sea; and thirdly, we see them refracted as thro' Dioptra; which here must mean an Instrument furnished with Convex or Concave ground Glasses, or something analogous thereto, perhaps of Talc, Crystal, or Isinglass, as they are the only Kind of Sights that do refract.*

Plutarch, in the Life of *Marcellus* says, that on the taking *Syracuse*, as * *Archimedes* was carrying a *Dial*, *Spheres*, an *Angle* or *Quadrant*, and some other *Mathematical Instruments*, wherewith he was used to accommo-

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date

ταύτα πάντα. Καμπύλας δὲ γραμμῆς καὶ ὑδατὸς βλέπομεν γινόμενας. Καμπύλαι ἢ οὐκ ἔστιν βία διὰ τὴν πυκνότητα τοῦ ὑδατὸς ὕλην. Διὸ καὶ τὴν κοπὴν ἐν τῇ θαλάσῃ μακροδὲν καμπύλοισιν ὁρώμεν. Τρίτῃ τροπῇ τε βλέπειν τὰ ἀνακλωμένα ὡς τὰ καλοπτρικά. *Plutarch. De Placitis Philos. Lib. III. cap. v.*

* Pag. 309. Edit. *Ruald.* Ὡς καμίζοντι πρὸς Μαρκελλον αὐτοῦ τῶν μαθηματικῶν ὀργάνων σκιδναρὰ σφαῖρας καὶ γωνίας αἷς ἀνακλωτικαῖς τοῦ τοῦ ἡλίου μεγάλῃ πρὸς τὴν οὐκὴν ὄψιν.

date the Magnitude of the Sun to the Sight, as a Present to Marcellus, he was met by some Soldiers, who thinking it was Treasure that he carried in his Boxes, slew him. Is there not a strong Presumption, that these Instruments that demonstrated to Sight the Suns Magnitude, were Telescopes?

Cicero, says Archimedes *, who viewed it, has given cogent Geometrical Reasons, that the Sun is many times bigger than the Earth. What can he mean by Viewing it? *eo inspectante*, every body has seen the Sun; he must mean with such uncommon Instruments as enabled him to measure and assert its Magnitude. And in another Place he says, † *The Mathematicians very positively affirm, the Sun to be above eighteen times as big as the Earth.*

'Tis pretty plain from a Passage in *Jamblicus*, that they knew the Use of the black Glasses

* *Cicer. Academ. Quæst.* Tom. VIII. p. 26. Archimedes *eo inspectante rationes omnes descripsit eas quibus efficitur multis partibus solem majorem esse quam terram, &c.*

† *Nec magis affirmabunt signum illud si erunt mensi sex pedum esse quam solem quam metiri non possunt plusquam duo de viginti partibus majorem esse quam terram. Quæst. Academ. p. 26. Ibid. p. 18. Solem mathematici amplius duode viginti partibus confirmant majorem esse quam terram.*

Glasses for viewing the Sun. * *We are wont,* says he, *to favour the Weakness of the Eyes, by shewing the Eclipses through a well polished black Catoptric.*

Again, when he went Quæstor into † *Sicily*, he found out *Archimedes's Tomb*, on which was described a Sphere and Cylinder.

This great Man's Discovery of the Relation between the Sphere and Cylinder, has been of Use in the Mathematics: He likewise, I suppose, at the same time, found the Relation between the Sphere and the Pyramid, that it is equal to one whose Base is equal to the Surface, and its Height to the Radius of the Sphere; why then did not the Cone accompany the Cylinder on his Tomb, if designed to perpetuate this Discovery?

It is a judicious and common Custom even to our Times, to perpetuate the Actions of

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the

* Η καλοπρία των μελαναυγας δεικνυντι επινοησαντας εκληψαι; φειδομενοι της του αψευδους ασθενειας αυτων. *Jamb.* p. 54.

† *Tuscul. Disput.* Lib. V. p. 257. Animadverti columellam in qua inerat sphaeræ figura & cylindri.

the Deceased, by inscribing on his Monument the Instruments wherewith the greatest of them were performed. *Archimedes's* Sphere, or as we now call it, Orrery *, will ever be esteemed a noble Work ; But what was this Cylinder, (that all his other famous Machines wherewith he so long baffled the Armies and Navies of *Rome*, laid aside) it must be eternized on his Tomb ? Is it not more likely to have represented his Telescope ? That is the Shape we to this Day give them, and that has always been the most proper, it was a right Way of recording his having subjected the Magnitude of the Sun, &c. to human Sight.

† *Agellius mentions the multiplying Speculum, another, that placed in a certain Position, would exhibit no Image at all, in a different one*
it

* *Cicer. Tusculan. Disput. Lib. I. p. 157. Nam cum Archimedes lunæ solis quinque errantium motus in sphæram illigavit effecit—ut tarditate & celeritate dissimillimos motus una regeret conversio.*

† *Noct. Attic. Lib. XVI. cap. 18. in speculo uno imagines unius rei plures appareant : item ut speculum in loco certo positum nihil imaginet aliorum translatus faciat Imagines, item si rectus speculum spectes, imago fiat tua hujusmodi ut caput deorsum videatur pedes sursum.*

it would, others before, which if you stand upright, shew the Image inverted, which I suppose must have been a concave Lens, is it not plain then that the Ancients understood the Art and Use of Glafs-grinding, but I shall prosecute this Matter a little further.

Pliny shews, * that he understood, that transparent Bodies might be so ground as to collect the Rays and improve the Sight, *The Emeralds*, says he, *are generally Concave to collect the Sight*; and a little after, *That the Emperor Nero viewed the Fights of the Gladiators through an Emerald*. Its green Colour might recommend it, as we now frequently give a treble Price for green Spectacles. But what makes it plain that the Ancients commonly understood Optic Glasses, is the many curious Works we yet have of theirs so well performed, and so minute, that no Man could execute the like, without very good magnifying Glasses.

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The

* *Nat. Hist. Lib. XXXVII. cap. v. Smaragdi—iidem plerumque & concavi ut visum colligant. Nero princeps Gladiatorum pugnas spectabat Smaragdo.*

The Cabinets of the Curious are plentifully stocked with antique Intaglio's, or Seals sunk in Cornelian, Onyx, Agate, &c. These Gems are sculped by means of a small Iron or Copper Drill imbued with Diamond Powder; * for the modern Way of working them is the same as that of the Ancients, as these are sunk in a concave Surface, they require better Sight than engraving on a Flat. I have inquired of such Artists as I have met with, who have unanimously declared, it was impossible to do such Works without their Eye-glasses, through which I observed they constantly worked.

There is in the King of France's Cabinet †, a Cornelian, called Michael Angelo's Seal, not six-tenths of an Inch long, not four broad, wherein are represented seventeen or eighteen Figures, besides a Canopy, Trees, Foliage and Exergue,

* *Plin. Lib. XXXVII. cap. iv. Adamas in tam parvas frangitur crustas, ut vix cerni possint, expetuntur à scalptoribus ferroque includuntur nullam non duritiem ex facili cavyantes.*

† *Histoire de l'Academie Royale des Inscriptions, Tom. I. p. 333.*

Exergue, where there is a Landscape, with a River and a Man a fishing. These Figures are all Confusion, viewed with the naked Eye, but through a Microscope extremely beautiful. I will quit this Subject with a Quotation from the learned late Dr. John Freind, who says, Our illustrious Countryman, the great Roger Bacon, understood and explained the Nature of concave spherical Glasses, of which he wrote a Treatise, and shewed their Force in burning Things at a Distance. How far he advanced Optics in all its Branches, is evident from his Book of Perspective; where he discourses of the Reflexion and Refraction of Light, and describes the Camera Obscura, and all Sorts of Glasses which magnify or diminish any Object, bring it nearer to the Eye, or remove it further off: Among the rest, the Use of the Optic Tube or Telescope (though thought to be a more modern Invention) was plainly known to him. He was born A.D. 1214, and died 1292.*

* *History of Physic*, Vol. II. p. 235.

C H A P. VI.

The Earth's Motions variously accounted for.

BUT to return to the *Pythagorean* Astronomy. We find they held much the same System we do at present, as that the Sun was the Centre about which all the Planets revolve; that Saturn, Jupiter, Mars, were more distant from the Sun than the Earth, Venus, and Mercury; that the Planets were kept in their Places by their Velocity and Gravitation, which they alluded to by the Harmony of the Spheres, and illustrated by a Stone in a Sling, where the Arm of the Slinger represents the given Force or Velocity, and the String which prevents its flying off in a Tangent, the Attraction betwixt the Earth and Sun; but as the Stone would soon lose its circular Motion, were the force of the Arm to cease, so they must suppose a continued Miracle or Operation of a divine Agent to keep the Earth attracted by the Sun at its due Distance.

Of

Of this Difficulty, the great Kepler was apprized, for he allowed * *the Earth, &c. must in Time stand still, were these Motions not kept up by the Care of the Creator, or some Mind by him destined thereto, and that the Revolutions of the Planets is owing to the vectorial Power of the Sun; that is, Emanations from it continually proceeding in right Lines, and whirled about by his Revolution on his Axis, would carry them round him in the same time (they floating as it were in a River of these Emanations) were they not retarded by their Vis Inertiæ, which increases in Proportion to their Magnitude and Distance. And finding the Necessity of a Repulsion, as well as Attraction, in order to produce a circular or elliptical Motion, has recourse to a friendly and unfriendly Side in each, the one attracted, the other repelled by the Sun †.*

As the Ancients compared the Earth's Motion to the Stone in a Sling, our Moderns refine upon them by that of a Weight and Line appended

* See Gregory's *Astronomy*, Book I. Proposit. 66.

† Gregory's *Astronomy*, Book I. Prop. 68.

44 *The Earth's Motions variously accounted for.*

appended to a Hook, which, say they, being put into Motion, will acquire an elliptical one; and were it not for the Friction of the Air, *i. e.* could the Experiment be made in a perfect Vacuum, would for ever continue.

Though the Ether be a resisting Medium, I shall allow as much of this last as they please, and yet think there is no Parity of Reason, no Analogy betwixt the Hook and Sun, the Weight and Earth; because first, was in each the attractive Force only to act, the Earth would move in a direct Line as near the Sun as it could, but the Weight would recede as far from the Hook as it could, but chiefly for that it is but one Motion, *viz.* that of Projection confined only by the Hook and String, for the whole of Gravitation is taken off by the Hook, as I think will be allowed me at first Sight.

However, I made the following Experiment: I took a long slender String and Weight, which I exactly balanced in a Pair of

of good Scales, which I hung up in a Well of a Stair-case, for the sake of its Height, then gave the Weight a Motion as nearly circular as I could, after the Scales had fluctuated about a Minute, they remained in perfect equilibrium, though the Weight continued its Motion a long time after ; and it is equally certain, that if to a Weight so appended, a Motion exactly circular be given, it will continue without deviating into an Elipsis.

I took a round Table two Foot and a half Diameter, whereon were described Circles one within another, at one Inch and a half distance ; from a Pully over the Centre hung a Weight, which was placed near the Edge of the Table, and raised by means of the Pully, during the time of turning the Table, which was done by a Rope round the Box of the Pillar on which it stood ; this gave the Weight a circular Motion, which continued such, as near as I could judge by the Circles on the Table, till it quite stopped. I hope I may be excused for having mentioned

46 *The Earth's Motions variously accounted for.*

tioned these two trifling Experiments, occasioned by some Gentlemen insisting, that a circular Motion once given, would always continue, and that there was a natural Tendency in Bodies moved circularly to an Elipse.

CHAP.

C H A P. VII.

Projection and Attraction will not account for the Earth's Motions.

GRAVITATION is a Property we see universally lodged in Matter in Proportion to its Density, whereby it gravitates to, or is attracted by the Earth, the same Power is very natural to suppose existing between the Earth and Sun ; but as this Power would make it tend in a right Line to the Sun, another has been invented or supposed, which is not any where to be seen in Nature, *viz.* a projectile one ; and so the Earth's Motion becomes accounted for by the great Law of Gravitation, stamp'd by Omnipotence thereon, and a projectile Force impinged by the same Power which prevents it falling in upon the Sun.

The Action of these two Forces seem inadequate to such a Motion, because, in order to produce it, the gravitating Force must exactly balance the projectile one ; and I believe

believe it will appear that very soon after, the one must be intirely destroyed : They seem, by all the Geometrical Experiments I have been able to make, necessarily destructive of each other ; like Noise and Silence, like Ice and Fire, they cannot subsist together.

From a Consideration of the Nature of these two Forces, this Assertion will be verified. Gravitation is the Force whereby the Earth attracts all Bodies to its own, it is at all times uniformly exerted in right Lines from the Earth to the Body attracted, it acts equally on all Bodies according to their Densities, it is the Means God has made use of to support Nature ; but for this Property the Earth and all Bodies would crumble into Atoms, and all Form be destroyed, except that of a particular Atom ; it is, for aught we can perceive, made perpetual, subject to no Decay, needing no Reparation, Violence may overcome it, but its Duration soon conquers the Violence. We can throw a Stone up perpendicularly in the Air, but Gravity soon brings

brings it down again, and it is weakened only as it is removed from the Centre wherein it is placed : But Projection is a Motion given to Body contrary to its Nature, which would always be at rest, and when given, it would always continue in a strait Line, if nothing hindered it, but not capable of removing any Obstruction, without losing some of its own Force ; and the Obstruction given by Attraction, must produce on the projected Body the same Effect as Obstruction given by Ether, Air, or a denser Medium. Our Attraction acting on the Projection, continually disturbs and alters its Aim from a strait Line to a Circle, and as it has no perpetual Duration like Attraction, must soon be overcome, and cease.

A Mortar elevated forty-five Degrees, ejects a Bomb at first, in or near a right Line, that is, while the projectile Force is vastly superior to Attraction, afterwards coming near a Balance in a Curve, and for the Moment the two Forces are in equilibrio in a Segment of a Circle, and then in a Curve, tending still

E

more

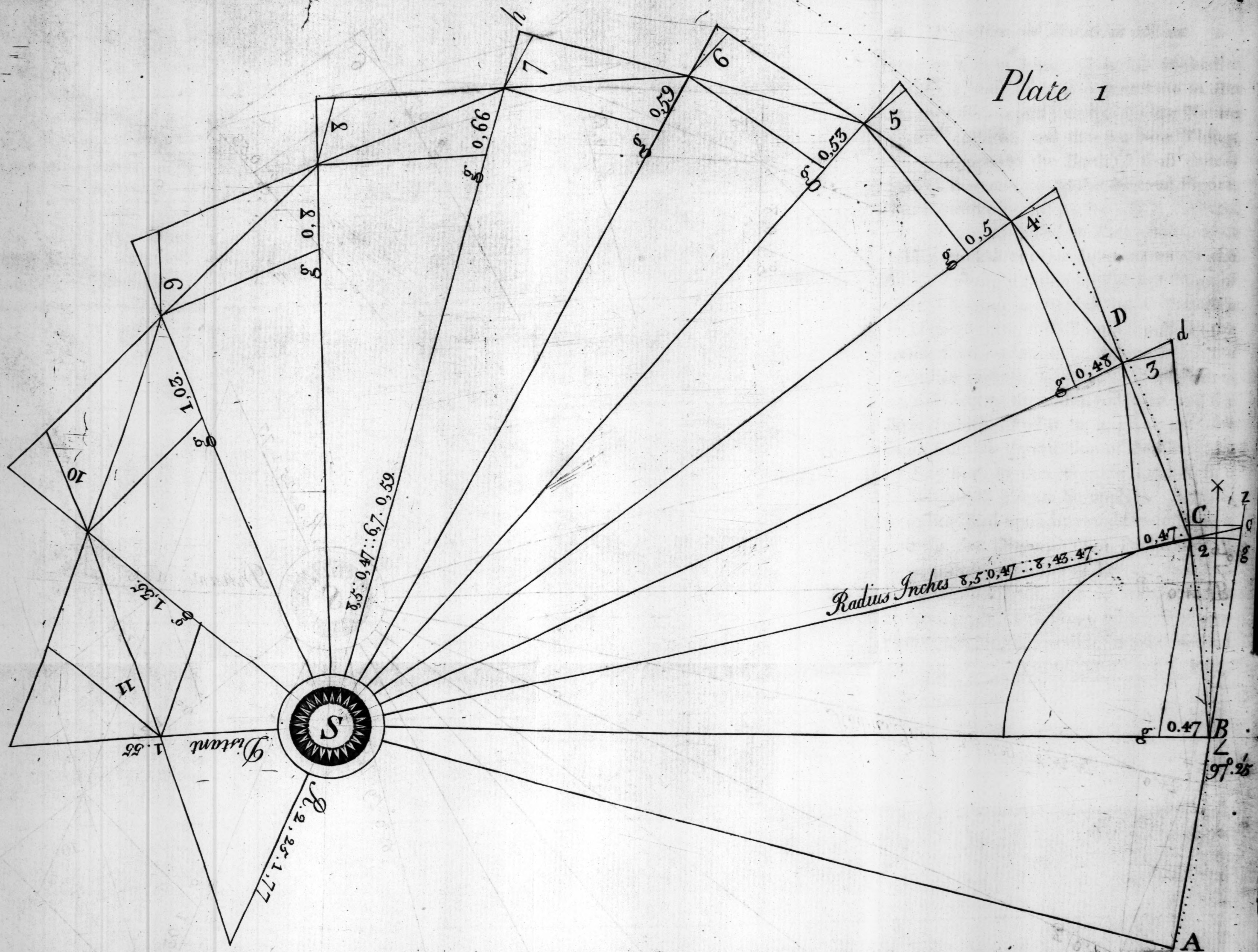
50 *Projection and Attraction will not*

more to a right Line, till it has finished a Semicircle, and then in a strait Line to the Centre of Gravitation; that this is the Nature of all Projectiles, and that the same Things would happen to the Earth, I shall endeavour to demonstrate by the annexed Figure, Plate I. where

The prick'd circular Line represents the Earth's annual Motion: In the first Point of Time I suppose it moved by a projectile Force in the Line A to B, and would, in the second Point arrive at c, distant from the Circle half an Inch, or 0, 5. A Force therefore sufficient to draw the said 0, 5 into the Circle (which I find to be 0, 47, or the Line drawn from the Intersection of the Circle, by the Ray S. c. to the projectile Line A. B. c parallel to S. B.) must be apply'd. And as all Bodies acted upon by two different Forces, move in the Diagonal of a Parallelogram, compounded of those two Forces, so a Parallelogram described, one of whose Sides is in the Ray A. B. c. along which the projectile, undisturbed, would, in the second

Point

Plate 1



Point of Time, have passed, and by which the projectile Force is represented, and the other, 2. g. from where Radius S. c. intersects the Circle (as aforesaid) to the said Line A. B. c. and parallel to g. B. representing the gravitating Force; and not as has generally been taken from C. to c. because that implies an Absurdity, *viz.* that the Body impeded by the gravitating Force, moves as fast as unimpeded, and indeed faster by as much as the circular Line B. C. is longer than a right one to the same Points.

The Ray S. B. or gravitating Force makes an obtuse Angle of $97^{\circ}.25'$ with the Line A. B. c. or projectile Force, and of course must act in a contrary Direction as much as the $7^{\circ}.25'$ of Obliquity is able, which will retard the Motion 0, 16. Inch, or the Distance from the Intersection of the Circle by Radius S. c. to C. For I presume it will be allowed me, that if the gravitating Force be equal to the projectile, and a new one likewise equal acts on it at same Time in an opposite Direction or Angle of 90° . it would immediately stop it, or prevent the Motion of two Inches,

E 2

which

which it has in this Diagram ; if therefore the Force 90. destroys 2 : 7°. 25 destroys 0, 16. for $90 : 20 :: 7, 25. 0, 16.$ So that the Calculation exactly agrees with the Mensuration, but indeed there is no need of Exactness in this Affair, since I have only to prove that the projectile does not in the second Point of Time arrive quite at C. for be it never so little short, it must move in a spiral Line to the Sun or Centre S. and it is equal to my Purpose, whether the Earth from the above Principles must impinge on the Sun in six Months or six thousand.

The Earth thus moves in the second Point of Time in the Diagonal of the Parallelogram from B. to 2. which continued, would in the third Point of Time arrive at d. but the same Forces and Reasons continuing, moves in the several Diagonals to 11. when it passes within 1, 6, Inch of the Sun or Centre, and the attractive Force being increased to 1, 77 Inch, must impinge thereon. The Length of each Radius is determined by the doubling of the preceding Diagonal ; the Breadth of the Parallelogram, by the Rule of Proportion, thus the Ray S. h. is long six Inches

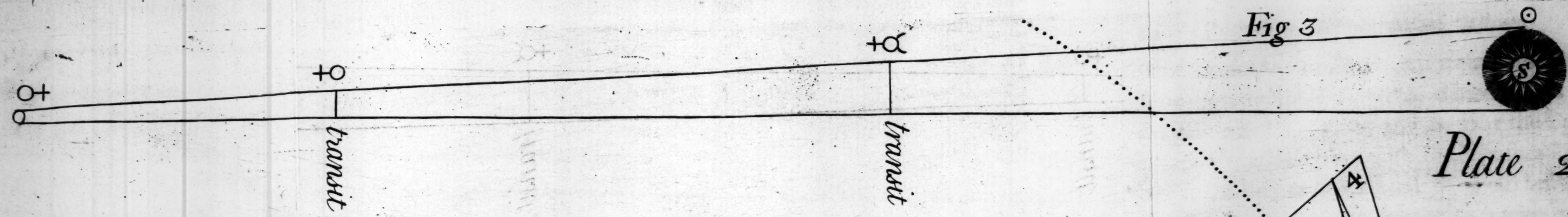
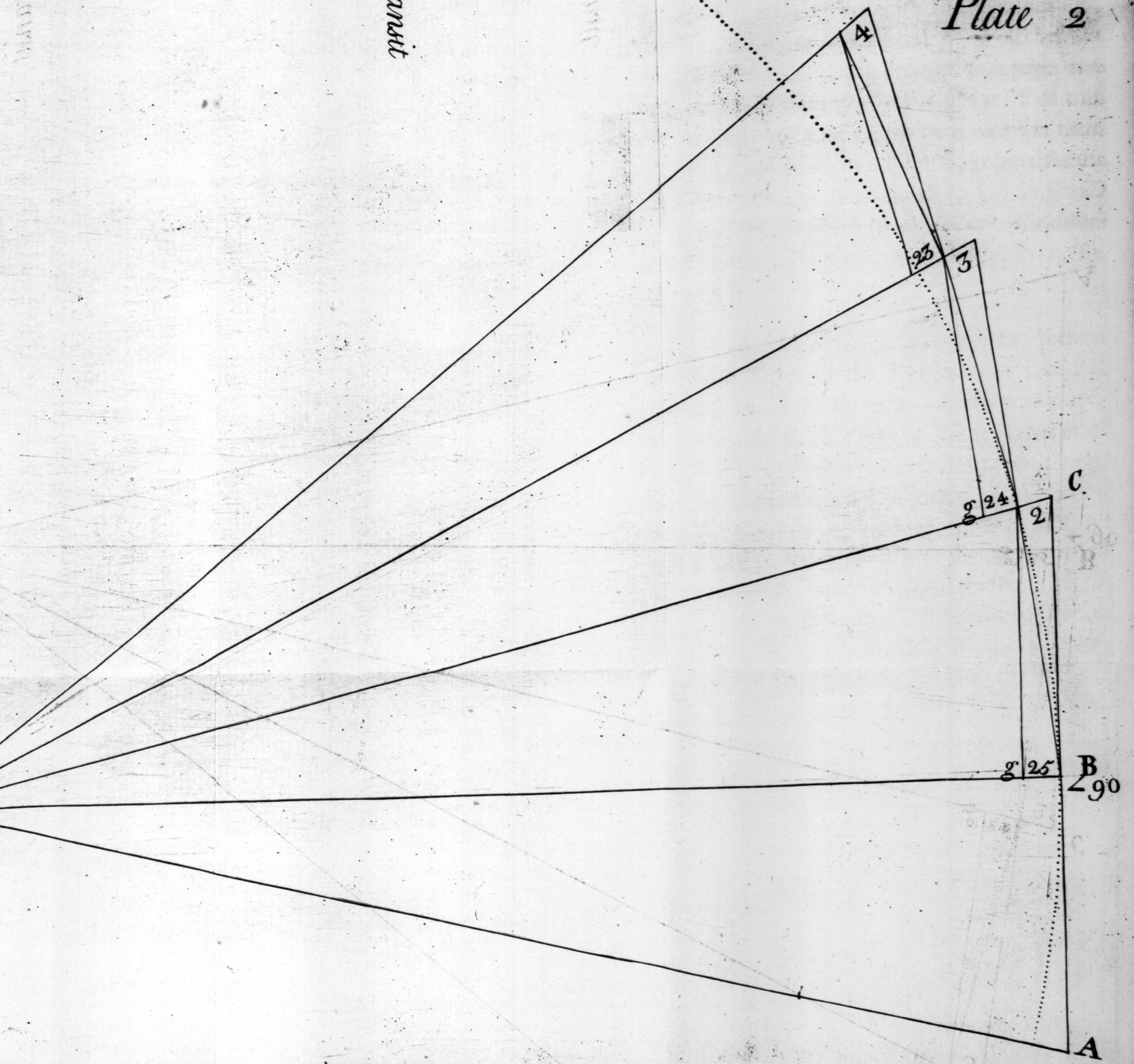
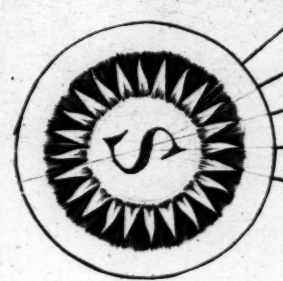


Plate 2

Fig. 4



Inches seven-tenths, so as the Ray S. c. long 8, 5. required 0. 47. the said Ray long 6, 7. requires 0, 59. as 8, 5 : 0, 47 :: 6, 7. 0, 59.

And in Plate II. Figure 1, the projectile is at right Angles with the gravitating, or Radius S. B. when it gives the Ray S. c. distant from the Circle 0, 25 Inch, which being the attractive Force sufficient to bring it to the Circle, and a Parallelogram constructed accordingly, gives in the third Point of Time a Ray 0, 5 Inch distant in the fourth 0, 8. and so on the Parallelogram growing narrower here in the Ratio it did wider in Plate I. till it goes off in a kind of spiral Line outward, as it did inward ; or if in the third Point of Time where the projectile becomes 0, 5. distant from the Circle, instead of 0, 25. the first needful attractive Force you take that 0, 5. the present necessary one, then all the same Things happen as in Plate I. only one Point of Time later.

Again ; Plate III, there is a View of the projectile at acute Angles with the Ray S. B.

though this may seem unnecessary, as it is plain that two combined Forces, both tending to the same Point, must be continually approaching thereto. However, to continue my Method of Demonstration here in the second Point of Time, it reaches the circular Line, and of course needing no Force to draw it into it, must continue to the third Point, when it arrives at d. distant from the Line o, 5. and so all the same happens, as in the two preceding Figures.

Having thus, I think, demonstrated that no projectile thrown in any Direction, or attended with any Force of Attraction can produce a circular Motion, and an elliptical one labours under greater Difficulties, because, beside the removal of the foregoing Objections, I suppose it will not be easy to assign a physical Reason why the Earth being in Winter nearer the Sun, should not have its gravitating Force increased, or why on the other Side the Ellipse in Summer, the projectile one should not likewise increase to the total Destruction of the one or other.

The

Plate 3.

Fig. 1.

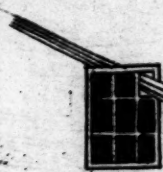


Fig. 2



The judicious *Derham* has rightly observed,
 * *That should the projectile Force of a Planet
 exceed the attractive, but to the Impulse of an
 Atom, or should the attractive as much overpower
 the projectile, the Consequence would be, that in
 a long Tract of Time, the prevailing Force
 would get the better of the other, and at last
 destroy it.*

* *Derham's Astro-Theology, p. 147.*

C H A P. VIII.

Of the Earth's diurnal Motion.

A GAIN; beside the Composition of the mentioned Forces of Projection and Gravitation, there must be a third supposed primarily impinged on the Earth; to wit, a twirl or circular Motion on its Axis, from whence the diurnal Motion must arise. Now, is it not plain that a Body so strongly attracted by the Sun as to keep it in an Orbit, and prevent it flying off in a Tangent, must have such a circular Motion presently stopped, at least impaired, as the Side next the Sun must be most pressed upon, the Attraction of all the Planets co-operating thereto.

I took an artificial Magnet that weighed 5 Oz. 120 Grains, and would lift up 4 Oz. 340 Grains. I hung it to a small String, and gave it so many Turns as would continue its revolving Motion $10\frac{1}{2}$ Minutes, when no Iron was near to impede it, but upon applying a Piece of Iron covered with a Pewter Plate,

Plate, within the Sphere of its Activity, it stopped in three Minutes, and the Iron being removed, it recommenced its circular Motion, which lasted but half a Minute more. Hence it is evident, that did not some Force continually act upon the Earth, to keep up its Motions, the attractive Power of the Sun would soon stop (at least) the diurnal one.

The Friction likewise of the *Æther* must be considerable, as this very Motion proves from its being prolonged to twenty-four Hours; for if nothing hindered it, why should not the Earth revolve in twenty-four Minutes, or indeed one second Minute?

This Resistance of the *Æther*, seems necessary to prevent the too rapid Motions of the Planets, and render them equable: And as the Earth floats in, and is surrounded by its Air, so does the Sun in the *Æther*, its proper Atmosphere, which must be extended as far as the utmost Limits of his System, and is the Medium the *Funiculi* or *Hami*, whereby the Sun attracts all the Planets and Comets,

mets, and prevents their flying out of the System.

As Comets move in Elipses *, and are kept in their Orbits by the same Forces as the Planets, let us consider that of 1680 †, which descending as it were from an infinite Distance, perpendicularly towards the Sun, arose from him again with as great Velocity.

As the Access to, and Recess from the Sun, were made in strait Lines, while they were making, the projectile Force must cease or be suspended; to stop but for a Moment any projectile, is absolutely to destroy its Motion, how came it then to be exerted with so much Vigour in the *Perihelion*? Was there a continued Miracle, a fresh Projection given, or was all done by means of Reflition, or Rebouncing? The yielding Æther is unfit for such an Effect.

This Comet ‡, during half its Circuit round the Sun, was distant from it but one third of the

* Gregory's *Astron.* Book I. Proposit. 35. Newton's *Princip.* Proposit. 40. Theorem. 20.

† Gregory's *Astron.* p. 885.

‡ See this Comet in *Whiston's System*.

the Moon's Distance from the Earth; wherefore the attractive Force must be vastly increased, and the projectile being destroyed, it must have impinged on the Sun's Body.

I shall now proceed to give my own plain Thoughts on what physical Principles the diurnal and annual Motions of the Earth are produced, having first premised an Observation of the last great Comet in 1743, because it was that which threw me upon an Inquiry into the assigned and real Causes of those Motions.

About Four o'Clock in the Evening of the 30th or 31st of *December* 1743, Sky serene, I had a distinct View of this Comet, when I plainly perceived the Tail considerably refracted on the North-West Side, as in the annexed Diagram, Plate II. Fig. 2. Not having observed this Phænomenon, tho' some time before I had viewed it with a good reflecting Telescope, the refracted Side of the circular Tail not being objected to my Eye, and even suspecting my own Eyes, I asked many of
the

the By-standers, who unanimously agreed in the above Appearance; which seems to demonstrate what I suppose has been generally presumed, that the *Æther* is a resisting Medium.

This then is my simple Scheme, the Earth being an oblate Spheroid, objected to the Sun in an Obliquity of $66^{\circ}. 30'$. the same which given to the Sails of a Windmill, occasions its most forcible Conversion*. The Rays of the Sun striking against the oblique Hemisphere, as the Wind against the Sails of the Windmill, keep it off, and at the same time make it turn on its Axis, the Shape of the Earth, whose Diameter under the Line is increased \dagger 63 Miles, assists at the Equinoxes. The *Æther* being a resisting Medium, and the Atmosphere (like the Extremities or Ladles of a Mill-wheel in the Water, or Oars of a Boat) striking in it, urges it into a progressive

* *Wolffius*, Vol. II. p. 238. gives 54 Degrees for the Angle of the Sails of a Windmill to the Axis: But an ingenious Workman observed to me, that where the Wind came in Gusts, 65 kept it more steady.

\dagger *Leadbetter's Astron.* Vol. I. p. 11.

five Motion, its own Gravity inclines it to the Sun's Centre, and of course keeps it in Equilibrio with the repelling Rays, as the Mercury in the Barometer rises and falls as the Atmosphere becomes heavier or lighter ; whence the Regularity of its Motions.

'Tis supposed likewise, that the Plane of the Earth's Orbit is in Winter in or near the Sun's Axis, or some Part whence the Rays are not so forcibly emitted; for which Reason the Earth must at that time approach nearer it, to keep up the Equilibre, the repelling Force being weaker, and in Summer being objected to the more forcibly repelling Rays, be driven to a greater Distance, so the annual Orbit must become elliptical.

C H A P.

C H A P. IX.

Of the Causes of the Earth's Motions.

THE Particles of Light and Heat coming from the Sun, may seem too weak a Counterbalance to the Weight of the Earth upon the Sun, but let it be considered that they strike incessantly on a whole Hemisphere or Surface of 99,721,200 Miles: That it strikes so forcibly on the Moon, to be reverberated or reflected very strongly upon us therefrom. And we see its several Reflexions, Refractions and Inflexions by our various Mirrors, that a very sensible Increase of Heat is perceived by standing near a Wall opposed to the meridian Sun, that it even adds Weight to Bodies *, as Antimony, Lead, Coral, Mercury; that a sudden Removal out of Darkeness into Light, affects our Eyes so as to make them water, nor can they bear to look at the Sun or any great Light; that it strikes with such Force on Water, to divide its Particles,

and

* *Memoires de l'Acad. Roy. des Scienc. Ann. 1709. p. 522.*
Lemery Cours de Chemie, chap. 5.

and prevent its becoming Ice, and on Metals, so as to enlarge their Surfaces, to raise the Quicksilver in mercurial Thermometers, and to melt, turn into Vapour, or pulverise almost all terrestrial Substances, that neither Light nor Heat penetrate Bodies, but force into their Interstices, and must of course be in some measure resisted, or they would be instantaneously hot through, which Resistance may produce the Effect I contend for.

This Force becomes visible in the Comets, we see the Atmosphere of the objected Side repelled by the Rays of the Sun so violently, as to be driven behind the *Nucleus*, to that vast Distance we see their Tails reach, and these Atmospheres are so dense, as generally to hide the fix'd Stars that lie behind them *; that the Tails are produced by the Cause here assigned, is plain from their being always found in direct Opposition to the Sun, or, where allowing the repelling Rays to be the Cause they ought to appear.

This

* *Wolfius* sub finem, Tom. III. *Hewelii Cometograph.*
Lib. VIII. p. 516.

64 *Of the Causes of the Earth's Motions.*

This was *Kepler's* Opinion *, and which the great *Newton* allows agreeable to Reason. Besides, as the Weight, or gravitating Force of all Bodies are increased or diminished in Proportion to their Approach to, or Removal from their Centres of Gravity; so the Earth being at such a Distance, may have its centripetal Force, so diminished as to be no overmatch for the repelling Rays of the Sun: And that there is such a repelling Force may further be collected from the great *Dr. Halley's* Observation, † *That the Motion of Saturn is so disturbed by the rest of the Planets, especially Jupiter, that the periodic Time of that Planet is uncertain for some whole Days together.* And *Mr. Maclaurin* says, ‡ *That the Action of Jupiter on Saturn, when greatest, (that is in their Conjunction when their Distance is least) is found to be $\frac{1}{204}$ of the Action of the Sun upon Saturn, and that the Action of Saturn upon Jupiter* is

* *Newton. Princip. p. 514.* Ascensum caudarum ex atmosphaeris capitum & progressum in partes à sole aversas, *Keplerus* ascribit actioni radiorum lucis, materiam caudæ secum rapiendum——non est à ratione prorsus alienum.

† *Gregory's Astron. p. 900.*

‡ *Account of Sir Isaac Newton's Discoveries, p. 303.*

is $\frac{1}{1923}$ of the Action of the Sun on Jupiter; what can be meant by this Disturbance of Motions or Actions on each other, but that Saturn is attracted by Jupiter from his Orbit $\frac{1}{204}$ part nearer him, and consequently as much nearer the Sun, and Jupiter $\frac{1}{1923}$ nearer Saturn, or further from the Sun? As these Conjunctions happen once in eleven Years, these two exterior Planets must have met long ago, did not the repelling Rays drive Saturn back again to his Orbit, and Jupiter's Gravitation reinstate him in his due Distance to the Sun.

If then the Light and Heat of the Sun striking against the Earth's obliquely objected Hemisphere, occasions its turning on its Axis or diurnal Motion, any Resistance in the Æther must occasion the progressive or annual one, the Earth's Diameter being known, must determine its Distance from the Sun; for as the Diameter is 7967, 8. (the Atmosphere generally allowed to be about 25 Miles being plunged into the Æther, measures little) the Periphery 25031, which multi-
F
plied

66 *Of the Causes of the Earth's Motions.*

plied by the Number of its Revolutions
365,25. gives for its Orbit 9,142,572.

And as it would move this Orbit by the
Impulse of the Rays of the Sun only, and as
the gravitating Force must necessarily be
equal to that impelling Force of the Rays,
so while by its rotatorial Motion it advances
one Mile, it is attracted another: If to a Ship
sailing down a Current at the rate of one
Mile an Hour, such a Gale of Wind or other
impelling Force were added, as on a stagnant
Water would drive it likewise at the rate of
a Mile an Hour, it must then sail two.

P. A. H. C.

CHAP. X.

The Earth's Distance from the Sun measured pedometrically.

THE Orbit therefore, which the Earth as above pedometrically measured, being doubled by the gravitating Force, makes 18,285,144. whose Semidiameter is the Distance of the Earth from the Sun, or 2,910,164 Miles, a small Distance where the Mind has been accustomed to the Idea of 86, or 137 Millions; but if we consider how great a Distance one thousand Miles high is, and then rise to an hundred thousand, and so on to twenty-nine hundred thousand, it may seem a very great Distance and Room sufficient for the Earth, and only two interior Planets.

How grand soever Nature is in her Designs, there is the utmost Frugality in the Execution; we see all Nature full, as Earth, Air, Water, and from some late Experiments of Abbe Needham, and others, even Fire abounds

68 *The Earth's Distance from the Sun measured.*

with Animalcules, that nothing may be created in vain, and tho' Space does not come under that Denomination the Æther must certainly be a created Being, a great deal of which, allowing the vast Distances of our modern Astronomers, seems created in vain. But do we not give too great Distances to the fixed Stars. A Gentleman * has attempted to demonstrate by an ingenious mathematical Calculation, that the nearest fixed Star is 6000 times as far from us as we are from the Sun ; and we so distant, say they †, that a Bullet shot out of a great Gun, would be 32 Years and a half flying with its utmost Velocity thereto.

Supposing the Stars to be Suns, and Centres of no larger a System than ours, there are three thousand Places for Systems lost ; but we are not sure our Notions of Light are completely just : For instance, was the vivid Light of Sirius, of the Nature of our solar one, the Earth would be sufficiently enlightened

* *Lowthorp's Abridgm.* Vol. I. p. 234.

† *Derham's Physico-Theology*, p. 28.

lightned by it alone. Was every Grain of Sand, or Particle of Matter in the Earth, an Eye directed towards it, each would receive a Pencil of Rays therefrom; and so many, were they equally refrangible and of a similar Nature with ours, must give a great deal of Light, beside what comes from the thousands other Stars in our Hemisphere.

A Candle set on an Eminence, may be seen many Miles; does so small a Body propel its Rays so far *quaquaversum*? When the Air is modulated by the Organs of the Speaker, so as to form an articulate Sound, it may be heard a great way round: Is all the Air so modulated, or does that which is first modulated, give such an Impression to the ambient Air, as causes the Perception of Air formed into such a Word?

The mildest Wine having stood some time in an Antimony Cup, will therefrom acquire a Quality violently emetic, and it will continue to have the same Effect on Wine after ever so many Repetitions; yet the Cup not lose any of its Weight.

A Drachm of Musk will perfume the Air of a thousand Churches, and not lose one Grain of its Weight ; can all this be Effluvia from the Musk, when nothing flies off ? Or must it not be the Æther, or some Body that freely pervades the Musk, Antimony, &c. and thereby acquires such a Form as gives the Sensation of Musk to every Nostril it touches.

There can be no Reason why Form should not be infinitely divisible as well as Matter, the Mind can as well conceive a Hook or Angle broke into infinitely small Hooks or Angles ; as a Globe broke into infinitely small Globules.

A Person that has had the Small-pox, Pestilence, or any other contagious Distemper, is rarely affected with it a second time ; may this not be owing to the Form of the Matter received into the Habit to which the circulatory Vessels having not been accustomed, a general Sickness or Disorder is occasioned ? And when the Matter of this unusual Form

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comes

comes to the minute excretory Ducts of the cuticular Glands, it there stops, and the Accumulation of this Matter occasions the Pustules or Buboes; but if the Patient recovers, and his Blood again should be charged with this variolous or pestilential Matter, the Canals having been stretched to the Form of such Matter, readily admit its Transpiration. May not a Star give such a Form or Impression to something in our Atmosphere, as may convey to our Sight the Idea of a fixed Star, without any Rays from it reaching our Eye any more than any Part of the Substance of the Musk does our Nose, or the Antimony our Stomach?

We are told too, * of several *new Stars* that have appeared and disappeared at regular Periods, one particularly by Mr. Kirke in the Neck of the Swan, which he discovered the 16th of August 1687, with an eight Foot Telescope; it grew bigger the 23d of October, when it might be seen with the naked Eye, until having arrived at its greatest Magni-

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tude,

* Derham's *Astro-Theology*, p. 44.

tude, it again became less and less, and at last invisible, even with a Telescope. By frequent Observations he discovered its Motions to be very regular, and its Period $404\frac{1}{2}$ Days. These Stars are generally, and with a great of Reason, taken to be Planets of some other System, seen in their nearest Approach to ours. Their Periods are too short to suppose them Comets, as that of this new Star is but 39 Days more than that of our Earth, its Orbit cannot be supposed much above a ninth Part bigger; how does this tally with these imagined Distances, when the Compass of an Orb completed in 404 Days, makes it appear to the naked Eye bright in some, to equal the Light of Venus, and at the other End of the Orbit, not to be visible with a good Telescope*?

The Air, from its different Density, refracts the Rays of Light differently, and so much, that even the Height of the Pole does not always appear the same†. The noble and diligent *Tycho Brahe* was mistaken no less than eighteen Minutes in the Meridian of

* *Derham's Astro-Theology*, p. 46.

† *Lowthorp*, Vol. I. p. 265.

of his *Uraniburg*, for which he made all his Calculations; and we have many other Instances of like Nature.

And besides the various Refractions made by different Densities of the Air, it is very probable the Earth may attract or divert from a right Line the Rays of Light differently, according to the Part they fall upon, the Mountains that are sharp-pointed most, the Champain least, according to * *Grimaldi's* Experiment (which has since been confirmed by Sir *Isaac Newton* †; who adds, *That the Rays are incurvated about the circular Edges of Coins, Stones, &c. (as if they were attracted thereby.)*

Put a Blade of Steel or thin Glass, ending in a Point, in a dark Place, let it be set near a little Hole through which the Light passes, and let the Light almost touch the Point of the Steel or Glass; the Rays will bend in such a manner near it, that the Ray next the Point,

* *Voltaire's Elements of Newton's Philos.* p. 88.

† *Principia*, p. 225. Radii in transitu suo prope corporum vel opacorum vel perspicuorum angulos (quales sunt numerorum ex auro, argento, & ære cisorum, termini, rectanguli, circulares, &c.) incurvantur circum corpora, quasi attracti in eadem.

74 *Opinions of the Earth's Distance from Sun.*

Point, will be more Curve, and the farthest from it less so in Proportion. As in Figure 2. Plate III.

Now as no certain Parallax of the Sun is pretended, those of Mars and Venus doubted, the great and ingenious Dr. Halley* observes, *That the Transits of the Comets afford us the best Means, though they seldom happen to determine the Distance of the Earth and Sun, which hitherto has been attempted by Mars in his Opposition to the Sun, or else Venus, in perigæo, whose Parallaxes, though triple to that of the Sun, are scarce any-ways to be perceived by our Instruments.* In an Affair, I say, of so much Uncertainty upon any Principles but those I go upon, where the 365 diurnal Rotations of the Earth measure its Orbit, as a Pedometer or Surveyor's Wheel does its Surface, why may not this Distance of 2,910,164 Miles be admitted, especially as not differing so much from *Ptolomy, Copernicus, Tycho Brabe, Bullialdus, Kepler, Hevelius*

* *Gregory's Astron. p. penult. Sgravesand, Vol. II. p. 134. Martis Paralaxis Observationes subtilissimas effugit. Keill. Introduct. ad ver. Astron. p. 346.*

Opinions of the Earth's Distance from Sun. 75

lius or Ricciolus, as Cassini and Sir Isaac Newton do in going beyond them, or coming short of *De la Hire*? That this Position may better appear, have placed our several Opinions in one View, beginning with my own, as being the smallest Distance, viz. 2,910,164

Ptolomy, Copernicus, and Tycho } 4,302,625
Brake - - - - - }

Bullialdus - - - - - 5,495,550

Kepler - - - - - 12,907,876

Hevelius half as much more - 19,361,814

Ricciolus doubled *Kepler* - 25,815,752

Cassini and Sir *Isaac Newton* - 86,051,398

De la Hire - - - - - 136,923,591

lowed Data, viz. the Earth's Motion and Magnitude, which we find to excellently adapted to every Purpose of animal and vegetable Life, as abundantly shews the Wisdom of the Creator. We are to observe, that it could not be fit for the Habitation of such Animals as he has been pleased to place thereon: It is so large, that we see many Marshes, Heaths, and Bogs, for want of a sufficient Decivity to carry the Rain in Torrents to the Sea, and so small, that we see Beds

C H A P. XI.

Advantages from the just Size of the Earth.

WE see how much these great Men vary from one another, though most of them furnished with very good Telescopes, so difficult are mathematical Demonstrations, where there is no incontestible Datum evident to Sense to set out upon. - And as there is so much Difference about Distance, there must be as much about Magnitude. I shall therefore endeavour at a Probability of Certainty, by proceeding from known and allowed Data, viz. the Earth's Motion and Magnitude, which we find so excellently adapted to every Purpose of animal and vegetable Life, as abundantly shews the Wisdom of its Creator. Were it bigger or less, it could not be fit for the Habitation of such Animals as he has been pleased to place thereon: It is so large, that we see many Marshes, Heaths, and Bogs, for want of a sufficient Declivity to carry the Rain in Torrents to the Sea, and so small, that we see

Beds sufficiently deep for our Rivers in general, and many steep Cliffs and Gullies worn by the Rapidity of the Waters, owing to the full great Declivity, which if any-ways increased, would be very inconvenient for Passage, and the Land would by this means be so drained of its Waters, as to be unfit for Vegetation.

The Surface of a Globe increases above thrice as much as the Diameter: Were the Earth as big again, it would be three times as level, the Waters would stagnate and corrupt, the Earth would be too soft and spongy to produce Nourishment for Man and the larger Animals, and too full of Bogs and Quagmires to bear their Footsteps: Of this we have many Instances, as Things are at present; in the Country I live in, particularly one*: Whereon, if a Man jumps up, he shall see the Moss undulate round him for thirty or forty Yards; and a Horse would be immediately swallowed up, should he attempt to

* *Chatt Moss*, in *Legh* and *Eccles* Parishes in *Lancashire*, eight Statute Miles long, and four broad.

78 *Advantages from the just Size of the Earth.*

to walk over it. The *Rhine*, that vast and rapid Body of Water, as soon as it reaches the Levels of the *Low-Countries*, so loses its Force, for want of a sufficient Declivity, as not to be able to continue a River to the Sea, though got so near it, but is lost in Quagmires, Marshes, and insignificant Canals, soon after it has passed *Utrecht*, and very much lessened by Streams flowing from it, before it reaches thereto; and there are a great many Instances of the like Nature. And the Cataracts of *Niagara* *, whose Fall is 600 Foot, and many others shew to how great a Nicety the Earth's Magnitude is calculated, how even the Scales hang between Declivity and Level, when so small a Matter makes one or other Side preponderate.

As there is a natural Concatenation in the Mind of the Ideas of Magnitude and Distance, so every Mistake of Distance must produce a corresponding Error in our Ideas of the Magnitude of the Object; and, *vice versâ*; of course, if my Distance be allowed, the
Sun's

* *Hennepin's Discovery of America*, Vol. I. p. 29.

Sun's Size, must be proportionably lessened, and whatever demonstrates the one, does the same by the other; shall therefore, as soon as I have assigned the Distances of the Planets on the abovementioned Principles, give presumptive Reasons why the Sun cannot be so large, and demonstrate by Experiment, that the Distances cannot be so great as is pretended. Mercury is the nearest the Sun, and revolves about him in 87 Days, but being too near to have the Rotation on his Axis hitherto observed, and as I propose such Magnitudes and Distances as the Bodies themselves pedometrically measure, must first consider those whose Time of Rotation on their Axis, as well as Revolutions in their Orbits, is known, and then from Analogy, lay a probable Foundation for the Time of Mercury's diurnal Rotation, and thence his Size and Distance.

C H A P. XII.

- Venus's *Magnitude and Distance from the Sun.*

OF these, the next is Venus, which finishes its Circuit about the Sun in 224 Days, 17 Hours, and 44 Minutes, or 323,624 Minutes, and revolves on its Axis in 23 Hours or 1380 Minutes, and of course has 234 Revolutions in an Orbit. Now as the Earth's Time is to its Distance, so is Venus's Time to her's $525,949 : 2910,164 :: 323,624. 1790684$. Venus's Distance from the Sun, which doubled, is the Diameter of its Orbit, or 3,581. 368, and its Periphery 11,251,225. And as Planets measure perodometrically one half of their Orbits, so the one half of Venus's 5,625,612 divided by the Number of its Revolutions 234, give its Periphery 24041, its Diameter must be 7652 Miles.

She

Venus's *Magnitude and Distance from the Sun.* 81

She is distant from the Earth 1,119,480 Miles, Space enough to prevent any considerable Disorder from the Excentricity either of the Orbits may have, as that of the Earth cannot be above one 45th Part of its Orbit, the brumal Semicircle or Passage of the Earth from Libra to Aries, being but eight Days, or one forty-fifth of three hundred sixty-five Days shorter than the opposite or Æstival, which makes but 64670 Miles, or about a seventeenth of their Distance from each other.

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C H A P. XIII.

Mars's Magnitude and Distance from the Sun;

THE next to come under our Consideration is Mars, who completes his Orbit in 686 Days 23 Hours and 31 Minutes, or 989,251 Minutes, and revolves on his Axis in 24 Hours 40 Minutes, or 1480 Minutes, so has 668 Revolutions in each Orbit; wherefore allowing the Distances as here supposed, and to continue the same Method of Calculation by the noble or golden Rule of Proportion, as the Earth's Time is to its Magnitude, so is Mars's Time to his $525,949 : 2,910,164 :: 989,251. 5,473,690$, which is Mars's Distance from the Sun; the Diameter of his Orbit must be 10,947,380, and the Periphery 34,392,288, half thereof is 17,196,144, which divided by 668, the Number of Mars's Revolutions in an Orbit gives 25,742. for its Periphery, and the Diameter is 8,181 Miles.

Mars's Magnitude and Distance from the Sun. 83

Here is a remarkable Congruity in three Globes arising from Peripheries, divided by very unlike Divisors, viz. Venus 234, Earth 365, and Mars 668; here these Planets regularly and considerably increase in Distance, and their Magnitudes but little varied to fit them for the Use of their Inhabitants; any of them may be taken for the Standard of Fitness, and the others proportioned thereto. Venus is 315 Miles less than the Earth, Mars but 214 bigger, a very trifling Difference in Bodies so large, and yet even these not without Design for the Benefit of them both.

Venus being nearer the Sun, must be more heated thereby, and of course its Waters and Moisture more raised into Vapour, all that is raised, must descend in Rain or Dew; so that it must have more wet Weather than we have, and require more Declivity, or a smaller Orb, to carry the Waters quicker off, that they do not stagnate and corrupt by the greater Heat.

84 Mars's *Magnitude and Distance from the Sun.*

And Mars, on the same Principles, ought to be somewhat larger, because having less Heat, and consequently less Rain, it may be necessary that it continue a little longer for the sufficient moistening the Glebe.

This Planet, it is true, is so near us, that we might presume his Size might be judged of by Vision ; but is it certain that his Atmosphere may not deceive us ? It is so very gross that the fixed * Stars seen through it, appear extremely obscured and almost extinct ; it is vastly larger in Proportion to ours, as is proved † by the *Alteration of the Colour of a fixed Star, observed by Mr. Romer, as it approached and quitted the Disk of Mars ; it grew sensibly pale on approaching this Disk, being yet above two-thirds of its Diameter distant ; and coming from behind the Planet's dark Body, did not recover the natural and usual Vivacity of its Light, till it came to the Distance of two-thirds of the same Diameter.*

And

* Pemberton's *View of Sir Isaac Newton's Philos.* p. 237. and Chambers in Mars.

† Voltaire's *Elem. of Newton's Philos.* p. 289.

And his own Body appears of a rusty Red, whence his Name, and such as any bright Body would through Smoke, which will both obscure and diminish any luminous Body, and is the Reason, I suppose, why Mars is reckoned so much less than the Earth, though much more distant from the Sun.

I lighted three large Candles tied together, and took the Size of the Flame, as well as I could, by an extemporaneous Micro-meter, then caused a considerable Smoke in the Place, where it stood, by stopping the Chimney, the Size of the Flame appeared considerably lessened, and of a dark red Colour, though I was but at the Distance of twenty Yards.

We see, and are Judges of the Conveniencies arising from the Shape and Size of our Earth, we are not sure what Differences of Augmentation or Diminution may seem to arrive to the Planets from being viewed by our Glasses through Atmospheres of

86 Mars's *Magnitude and Distance from the Sun.*

different Natures from ours, and I had rather therefore suppose, that the Almighty's Goodness has transferred the Commodiousness we are blessed with to other Worlds, than deny them, because my Glasses do.

* When the Comet of 1680 and 1681 became no more visible by the naked Eye, it might for a good while after be seen with a Telescope; and what was very extraordinary, it might be viewed much better with one of four Foot, than a more excellent one of twenty Foot long, and appeared larger than even Jupiter. What a Capriciousness is here in this optical Machine, which is to determine the Magnitude and Distances of the Planets?

Who could have thought (*à priori*) that a Prism could separate the Colours of a Pencil of Rays by its unsuspected Refractions in the manner we see it? Of all the possible Properties of Light, we cannot possibly judge, having made no Experiments in any Atmosphere

* *Wolffius*, Tom. III. p. 578.

Mars's Magnitude and Distance from the Sun. 87

sphere but our own. And Mathematicians acknowledge, that the Optic Theorem* concerning the apparent Diameters of Objects being in reciprocal Proportion to their Distances from the Eye, can only take place where the Diameter of the Object does not bear too great a Proportion to its Distance.

As we see through all Nature, Order, and Regularity, according to our Sense of the Words, so the Planets, in their Times and Distances, increase orderly and regularly from Mercury's Revolution in 87 Days, to Saturn's 10759; so from Mercury's near Vicinity to the Sun, to Saturn's immense Distance.

But it is far otherwise where Optics are to determine, viz. in their Magnitudes, where Mercury is but about a third as big as the Earth†. Venus a little above half, Mars, who is thrice the Distance from the Sun, not

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quite

* *Wolffius*, Tom. III. p. 570.

† *Derham*, p. 12, 13. Mercury's Diameter 2748 Miles. Venus 4987. Earth 7967. Mars 4875. Jupiter 120653. Saturn 93451. These, he says, are the mean Numbers between *Messier*, *Flamsteed* and *Whiston*.

88 Mars's *Magnitude and Distance from the Sun.*

quite as big as Venus; the next Jupiter, above eighteen Times as big as the Earth; and Saturn, whose Time and Distance trebles Jupiter, but about two-thirds as big as Jupiter.

Here seems Irregularity and Confusion; upon my Scheme Venus and Mars measure themselves to the Magnitude I have assigned. But for Jupiter, if as large as is pretended, and its Motions so rapid, we must suppose it designed for some Use different from that of our Earth.

But as Mars's Atmosphere (according to Mr. Romer's Observation) is vastly large, compared with ours, which is but about 25 Miles, or at most 47 high*; and his two-thirds of his Diameter, or 5454 Miles; or according to the smallest Computation, 3250; so Jupiter's Atmosphere is probably high in Proportion; and as his is thick and dusky, which makes him look red and less,

Jupiter's

* Leadbetter's *Astronomy*, Vol. I. p. 11.

Mars's Magnitude and Distance from the Sun. 89

Jupiter's seems composed of clear whitish Particles, like frozen Water, which makes him appear white, and may magnify him.

And it is probable, that the Magnitude generally assigned is, that of his Atmosphere, and that his Body has not yet been sufficiently observed, or justly estimated.

CHAP.

C H A P. XIV.

*Observations on Jupiter's Atmosphere, Size
and Distance from the Sun.*

MR. Maclaurin says, * *There are sudden and surprising Revolutions on the Surface of the great Planet Jupiter, and such as would be fatal to the Inhabitants of the Earth. And it is observed in the Scotch Physical Essays just published, That more † surprising Phenomena have been observed on the Body of Jupiter, than any other Planet in the Solar System; among which the several Belts observed by Cassini, to rise in an Hour's Time, are not the least extraordinary. Spots likewise of very different Forms have frequently been seen on that Planet's Body. These Mr. Maclaurin suspects owing to Tides analogous to Spring-Tides; but with regard to the famous Phenomenon that some of his Spots move faster than others, it is better (say they) not to attempt any Explication, till the same be confirmed by more Observations.*

Now

* *Account of Sir Isaac Newton's Philos.* p. 391.† *Monthly Review for September 1754.*

Now these Spots that revolve, some faster than others, absolutely prove, that they are not fixed on his Body, but float at a Distance, or perhaps at different Distances in his Atmosphere. One may therefore pretty safely prophesy, that future Diligence and Improvements in Glasses, will discover a Size analogous and proportional to the others of the same System.

And shall venture to assign him such a one; in order to which have only to fix his Revolution on his Axis to a Time proportionable to the three we are more sure of, as for the Times of their compleating their Orbits round the Sun, they are known to a Minute, and it is scarce possible there should be the least Mistake therein.

As no Observations have yet determined the Time of Mercury's Rotation on his Axis, the same Proportion may be carried downward to it, as upwards to Jupiter and Saturn, which will bring it to 21 Hours 30 Minutes.

Minutes. Venus, as known, compleats her's in 23 Hours, or an Increase of 90 Minutes from the Time of Mercury; the Earth in 24 Hours, which is an Increase equal to $\frac{2}{3}$ Parts of Venus's; Mars in 24 Hours 40 Minutes, equal to $\frac{2}{3}$ Parts of the Earth's Increase: So Jupiter in 25 Hours 7 Minutes, or an Increase of 27 Minutes, being $\frac{2}{3}$ of Mars's, and Saturn in 25 Hours and 25 Minutes, or an Increase of 18 Minutes equal to $\frac{2}{3}$ Parts of Jupiter's.

Who compleats his Orbit round the Sun in 4332 Days 12 Hours 20 Minutes, or 6,238,820 Minutes, and has 4153 Revolutions on its Axis in an Orbit. Now as the Earth's Time is to its Distance, so is Jupiter's Time to his, 525,949:2910,164::6,238,820. 34,520,432, which is Jupiter's Distance from the Sun, which doubled, is the Diameter of his Orbit, or 69,040.864. its Periphery is 216,898,778. half of which divided by 4139 the Number of Jupiter's Revolutions in an Orbit, gives 26202, or Jupiter's Periphery, and his Diameter must be

8340 Miles ; but as what has been here advanced for Jupiter's Revolution on his Axis, is an acknowledged *petitio principii*, as Matters of Fact are stubborn and inflexible, and will not ply to any Hypothesis; if upon a careful Examination of this Phænomenon, it appears that he does revolve in about 9 Hours 56 Minutes, we must own, that the Ways of God are past Man's finding out. We cannot conceive of what Metal so vast a Globe is made, that is not whirled to pieces by so rapid a Motion as 624,250 Miles a Day to compleat his Orbit, and besides turning on his Axis at the rate of * 990,720 Miles in the same Time.

* Vid. *Derham's Astro-Theology*, p. 13.

CHAP. XV.

Of Saturn's Magnitude, Distance and Ring.

SATURN is the most distant Planet of the Solar System hitherto known, his Rotation on his Axis has not been remarked; so on the Footing above-mentioned, of a regular proportional Increase, shall assume 25 Hours 25 Minutes for his diurnal Motion.

The Time of his compleating a Revolution round the Sun, is 10759 Days 6 Hours, 36 Minutes, or 15,493,356 Minutes, and has 10159 Revolutions on his Axis in an Orbit. To proceed in my former Method, as the Earth's Time is to its Distance, so is Saturn's to his $525,949 : 2,910,164 :: 15,493,356$. 85,727,320 Miles, his Distance from the Sun. The Diameter of his Orbit is 171,454,640; the Circumference thereof 538,463,896, one half of which, divided by 10159, gives Saturn's Periphery 26510, his Diameter is 8438 Miles.

And

And besides his having every thing in common with the rest of the Planets, there is one peculiar to himself, his Ring a surprisingly large Arch, very near as broad as a Semidiameter of Saturn, an amazing Concave of 4000 Miles Diameter, according to my Mensuration, according to others, * 29200, the Cause and Cure of his vast Distance from the Sun, which is about 30 times as great as that of the Earth: This serves strongly to reverberate the Rays of the Sun on Saturn's Body, and like a Congeries of innumerable burning Glasses warms his frozen Atmosphere, doubling the Light as well as Heat, and this Contrivance gathering all the Rays as the concave Sails of a Ship do all the Winds, propels him to the Distance we almost shiver to think of.

* *Derham's Astro-Theology*, p. 188.

C H A P

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CHAP. XVI.

Mercury's Magnitude and Distance from the Sun.

HAVING omitted to say any thing of Mercury's Magnitude or Distance in his proper Place next the Sun, for Reasons there assigned, shall give them on my Principles. Supposing therefore, as was before observed, that he turns on his Axis in 21 Hours 30 Minutes, or 1290 Minutes, and has 98 Revolutions on its Axis, in an Orbit round the Sun in 87 Days 23 Hours 14 Minutes, or 126674 Minutes, to proceed therefore as with the others. As the Earth's Time is to its Distance, Mercury's Time is to his, $525,949 : 2910,164 :: 126674, 700758$; Mercury's Distance from the Sun's Centre, which doubled, is the Diameter of his Orbit 1,401,516, the Periphery 4,403,002, half of which, divided by the said 98, gives 22464, Mercury's Circumference, his Diameter is 7150 Miles,

Here

Here it must be allowed Mercury makes a very near Approach to the Sun's Centre, being within 700,758 Miles thereof; which, if as has been before observed, we will allow ourselves to weigh how great a Distance one thousand Miles is, and then rise to seven hundred thousand, it may be allowed a sufficient Distance, to prevent its being injured by this vast Dispenser of Heat to the whole System.

Besides, the Author of Nature, who has made nothing in vain, could very easily furnish this Planet with such Parts as would sufficiently enable it to resist this Heat, though never so violent, how easily can we, by a Variety of frigoric Mixtures, produce Ice and intense Cold, as by Snow and Salt, Nitre, Allum, Sal Amoniac, &c.

* Mr. Boyle has, I think, fully proved by many Experiments, that Cold is a positive Quality, acting by Corpuscles of Cold, and

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* *History of Cold*, passim.

98 *Temperature of Heat under the Line.*

not a mere Privation of Heat ; Nitre and Sal Amoniac, which abound most in Southern Climes, yield the most of these frigorific Particles.

* In a Cave at *Chaux*, near *Bezancon* in *Alsace*, are found large Pyramids of Ice in the hottest Summers, and it is so cold, that one cannot with Ease stay in it, and the adjacent Country abounds with Nitre and native Sal Amoniac.

And the abovementioned † honourable Author, relates from the learned *Acosta*, That under the Line, when the Sun was in the Zenith, the Weather was so cold, they were forced to go into the Sun to warm themselves, &c. What could I do, says he, but laugh at Aristotle's *Meteors*, and his Philosophy, seeing, that in that Place, and at that Season, when all should be scorched with Heat, I and my Companions were a cold?

In

* *Philosophic Conversations*, by *Regnault*, p. 14.

† *History of Cold*, p. 192.

In Truth, there is no Region in the World more pleasant and temperate, than under the Equinoctial, although it be not in all Parts of an equal Temperature. The burning Zone is in some Parts very temperate, as in Quito and the Plains of Peru; in some Parts very cold, as at Potosi; in some very hot, as in Ethiopia, Brazil, and the Moluccoes.

And again; You may continually see on the Tops of these Mountains, Snow, Hail, and frozen Waters, and the Cold so bitter, that the Grass is all withered, and Men and Beasts that pass that way, are benumbed with Cold: This happens most commonly in the burning Zone, when they have the Sun in the Zenith.

A few more of such frigoric Corpuscles, would make Mercury comfortably cool, and habitable by Animals, little differing from terrestrial ones.

C H A P. XVII.

The Sun's Diameter and Revolution on his Axis.

THE Sun's Diameter, according to modern Calculation, is * 822,148 Miles, his Circumference 2,582,860. He revolves on his Axis, according to the accurate Mr. *Flamsteed* †, in 25 Days 6 Hours, or 606 Hours, so must turn at the rate of 4262 Miles an Hour, which is above four times as quick as does the Earth. As he is the Dispenser of Heat to the whole System, his Body must be intensely hot, as nothing can give what it has not in itself: Heat renders all Bodies fluid, his must therefore be extremely so; and this Fluidity may be a considerable Addition to its Splendor, as the illustrious *Boyle* has observed ‡, who speaking of Oil of Anniseeds in its coagulated and fluid State, says, *It was worth observing, how great*

* *Derham's Astro-Theology*, p. 13.

† *Lowthorp's Abridgement*, Vol. I. p. 279.

‡ Ditto, Vol. I. p. 532.

great a Difference there was between the dull Reflexion it made when it was coagulated, and the fine Reflexion it made whilst it was a Liquor, the latter of which Reflexions brought into my Mind how vivid the reflective Power of some Fluids is in Comparison of that of the generality of solid Bodies.

The Earth, by the great Velocity of its diurnal Rotation at the rate of 1047 Miles in an Hour, having lengthened the Axis of his Equator 63 Miles, were the Sun to move with equal Swiftneſs (as his Parts muſt be ſuppoſed more fluid and volatilifed than thoſe of the Earth) would they not be liable to be diffipated, and thrown off at his Equator?

The ingenious Mr. *Derham* * made an Experiment of the Velocity of a Bullet when it firſt comes out of the Mouth of a Cannon, and found that it moved a Mile in 17 half-ſeconds, or 423 Miles an Hour, but the Sun (if as large as is pretended) moves above ten times as faſt,

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Were

* *Phyſico-Theology*, p. 28.

roz Sun's *Diameter and Revolution on his Axis.*

Were a grinding Stone whirled about with ten times the Velocity of a Cannon Bullet, when first discharged, the Water, or any other adhering Fluid would be immediately thrown off and dispersed in Air, and its Body, unless very firmly connected, shattered to Pieces.

The Distances of the Planets from the Sun, appear to have been reckoned much too great, so likewise does his Magnitude; and in a Mistake of the latter, was probably laid the Foundation of that of the former: The Truth of one, or both these Assertions, will, I think, be demonstrated by the following Experiment.

CHAP.

C H A P. XVIII.

*Experiments regarding the Transits of the
Planets over the Sun.*

HAVING considered the Deception that might arise from Lines and Angles drawn on Paper, where the Mistake of one tenth of an Inch might produce an Error of twice ten thousand Miles : I therefore, in a smooth level Field, having marked a Place for the Centre, drove down two Stakes at 41 Inches and one tenth Distance, to represent the Sun's Diameter of 822,148 Miles, allowing half an Inch for each 10000 Miles.

I then took another Stake 0, 4 Inches thick for the Earth's Diameter of 7967 Miles in the same Proportion, which I drove at 119 Yards $18\frac{1}{2}$ Inches for the Distance of the Earth from the Sun of 86,051,398 Miles.

I procured some fine and strong Cord, used by the Fustian Weavers in this Country, called *Simple Cording*, an hundred Yards of

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which

which weighed 2 Ounces 140 Grains. I extended this Cord as strait as it would bear round these Stakes, as in Figure 3, Plate II. and took care that they plaid freely on some smooth Canes; hereby I had two Lines, which may not improperly be called the ecliptic Lines of the interior Planets, because they cannot be seen from the Earth, but when between these Lines.

I then measured 86 Yards 16 Inches for Venus's Distance from the Sun of 62,243,557 Miles in like Proportion, and there measured the Distance of the ecliptic Lines, which I found to be 13 Inches, or 260000 Miles. I next measured 46 Yards 9 Inches for Mercury's Distance of 33,310,500 in the same Proportion, and found the ecliptic Lines distant 24, 8 Inches, or 293000 Miles. Now the Periphery of Venus's Orbit being 391,088,717, through which she moves in 5394 Hours, she must go at the rate of 72517 Miles in an Hour; and therefore pass over the Sun's Disk in 3 Hours 35 Minutes.

And

And the Circumference of Mercury's Orb being 209,296,533, which he moves round in 2111 Hours, he must revolve at the rate of 99619 Miles an Hour, and the Distance of his ecliptic Lines being 24, 8 Inches, must be passed over in 4 Hours 56 Minutes, which being a much shorter Time than they are already found to take up in such Transits, proves them to be reckoned at too great a Distance: The nearer they are to the Sun, the slower they must move, having a smaller Orb to pass round in the same Length of Time.

Though the Times of the Transits of these Planets may not yet be known with any Exactness, yet so much is known, that the sagacious *Halley* has observed *, that Venus may be 7 Hours 56 Minutes, and Mercury 8 Hours one Minute in such a Transit; so that Venus's Time being less than half of what it should be, and Mercury's a little
above

* *Lowthorp*, Vol. I. p. 432, 434.

106 *Experiments regarding the Transits, &c.*

above half these Distances, must be vastly too great. And as the ecliptic Lines grow wider as they approach the Sun, from his Diameter being larger than that of the Earth, these Planets must be placed nearer him, to solve their Phænomena.

C H A P.

C H A P. XIX.

Probable Reasons concerning the Sun's Magnitude and Distances of the Planets.

AND what has been before said of the Fluidity of Parts of the Sun, and the incompatible Rapidity of his Motion, if so large as has been pretended, may put us on considering such a Diameter as may bear some Analogy to the Motion of the Earth.

As that has $25\frac{1}{4}$ Rotations for one of the Sun, it is probable the Sun may contain $25\frac{1}{4}$ times as much Matter, or perhaps not quite as much, because his Atmosphere may possibly be more dense than that wherein the Earth floats; of which Opinion is the ingenious *Wolffius**; who says, the Sun's Atmosphere must be very dense from its so strongly reflecting the Zodical Lights, and very variable from their various Heights.

And

* *Wolff. Element. Mathemat.* Tom. III. p. 424.

And this Density may be of Use as well to prevent his Parts from flying off, as by clogging his Motion, to prevent its being too rapid.

The Earth's solid Contents is 264,779,336,392, which multiplied by 25, 25 gives 12,768,675,026,590. The Cube Root, or Diameter of a Sphere of that Contents is 23,373,044. With this reasonable Diameter of the Sun, and the pedometrical Distances of the Planets, the just-mentioned Experiment was repeated, allowing now an Inch for each thousand Mile.

Two Stakes were put down at 23,37 Inches Distance for the Sun's Diameter of 23373 Miles. At 80 Yards and 30 Inches, two other Stakes were put down 7,96 Inches distant, to represent the Earth's Diameter of 7967 Miles, and Distance from the Sun, according to my Scheme, being 2,910,164. And the same Cords extended as strait as possible round these four Stakes, whereby I

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had

had the ecliptic Lines. I then took 49 Yards $6\frac{1}{2}$ Inches for Venus's Distance of 1790664 Miles, and there measured the Width of the ecliptic Lines, which was 14,2 Inches, or 14 thousand two hundred Miles. Lastly, I took 19 Yards 16,75 Inches for Mercury's Distance of 700758 Miles, and there again measured the Distance of the ecliptic Lines, which was 19,7 Inches, or 19 thousand 7 hundred Miles.

As Venus's Distance from the Sun is 1790664, the Circumference of her Orbit must be 11251000 Miles, which she compleats in 5393 Hours, must move at the rate of 2086 Miles an Hour; therefore be 6 Hours 48 Minutes passing over these Lines, or the Sun's Disk. And Mercury's Distance being 700758, the Periphery of his Orbit must be 4403002 Miles, which he compleats in 2111 Hours, moving at the rate of 2085 an Hour; so must be 9 Hours 26 Minutes in the same Transition.

This

This Calculation differs not much from Dr. *Halley's*; and being made for the sake of Ease and Perspicuity, on a Supposition that they move in circular Orbits; and as we are pretty sure they move in Ellipses, the Obliquity of their Planes and Excentricity of their Orbits may account for this Difference; but supposing this should not exactly agree with the Observations of Mercury, and that to be made of Venus, *May 25, 1761.* this Method points out a Rule for mechanically coming at a Certainty, both of the one and the other, as the ecliptic Lines may be measured, and the Magnitude and Distances adapted to such a Mensuration.

C H A P. XX.

*Of the Crepuscula, or Twilight of the Earth
and Planets.*

ANother Cause of the Sun's Body being so much amplified, may arise from our comparing it with other Bodies in their Transits over his Disk, which must at such Time appear to us considerably less than they really are.

When we view Jupiter, Saturn, or Venus, we see the Rays of the Sun reflected from their Bodies, but in a Transit of a Planet through the Sun, we only see the Rays of the Sun environing the Planet, which by intercepting Part of the Rays, appears as a dark Spot in his Disk. Now these Rays being inflected by the Side between us and the Sun, by hiding Part of the circular Edge of the Planet, must make it appear by so much less the illumined Part of the Orb, not being seen by us as part of the said dark Spot. This is manifest from the Earth's not being immediately

diately darkened, the Moment the Sun is below the Horizon, the Crepusculum, or Twilight, must be owing to the Earth's intercepting the Rays, as in *Grimaldi's* Experiment *, or some other way, for so it be done, it matters not how.

And thus may we measure how much Venus really is bigger than she appears. Were a Transit of the Earth over the Sun, observed from Mars or Jupiter, it must appear one *twelfth* less than it really is.

As our Twilights are an Hour before and after the Sun, so a Mathematician in Jupiter or Mars would measure the Earth's Magnitude of 7967 only at 7303, the 663 Miles, or one twelfth, being enlightened, could be no Part of the opaque Spot to such an Observer. So Venus, viewed from the Earth, must have her Body diminished in Proportion to her Nearness to the Sun : For as $2910164 : 663 :: 1790684.1077$ for Venus ; for Mercury as $2910164 : 663 :: 700758.2753$. So that Venus

* See p. 73. of this Work.

nus appears less than she really is, by 1077 Miles, and Mercury by 2753.

And this is the largest these interiour Planets can appear from what we see by our Earth, but may possibly be a great deal more diminished, we can scarce guess how strongly the Rays may be bent back in so near a Vicinity to the Sun.

C. H. A. P. XXI.

The Moon not kept in her Orbit by Gravitation.

HAVING thus gone through the primary Planets, it may be expected I should account for the Phænomena of the secondary ones, but that I must wave for the present, because I suppose they are kept in their Orbits upon Principles very different from those of their Primaries ; to which only I intended to speak.

Our Moon (and probably those of Jupiter and Saturn) has no diurnal Rotation on its Axis ; therefore cannot measure its Orbit pedometrically according to my Scheme, having only one diurnal Revolution in an Orbit ; and that necessitated by its always keeping the same Phase to the Earth ; nor can I imagine any such repellent Force in the Earth, as I think, has been proved to subsist in the Sun, to change rectilineal Attraction into a curvilineal Orbit.

And

And if the Moon be kept in its Orb by the same Cause that preserves the Earth in its Course, why has not the like Cause like Effects? Why does not the Moon revolve on its Axis in the same Time the Earth does, or rather in less, from its being so much smaller.

C H A P. XXII.

The Attraction of the Earth of no large Extent.

Neither can I suppose, according to the Philosophy now in Fashion, that they are kept in their Orbs by the same means as the Primary; that is, by a Composition of a projectile and attractive Force; first for the Reasons before given that such a Composition could not produce that Effect; and, secondly, because how far soever that of the Sun may reach, the Attraction of the Earth does not seem to extend a great way; we see vast Quantities of heavy Rain and Hail float in the Air very near us, for a long time, the Earth not being able to attract or bring it down.

Mr. *Richer* *, found at *Cayenna*, near the Line, the Pendulum of his Clock vibrate so slow, that it was necessary to shorten it above $\frac{1}{10}$ of an Inch. This Experiment has since been repeated and confirmed by Messieurs *Deshayes*,

* See *Voltaire's Elements of Newton's Philosophy*, p. 193.

Deshayes, Varin, Feuillée, Couplet, and others, at *Quito*, and by *Dr. Halley*, at *St. Hellen's**; who there found it necessary to shorten the Pendulum of his Clock one tenth and a half, and some of these Experiments were made at a time when it freezed.

Now as we know that Gravity alone occasions the Vibration of a Pendulum, and that the Length of 39 Inches and two tenths from the Point of Suspension to the Centre of Oscillation will, vibrate Seconds, the Attraction under the Line must therefore be lessened above one four hundredth Part. Now as the Diameter of the Equator is but 63 Miles greater than that of the Poles, and *Paris* and *London* being little more than half way, they cannot be supposed above 16 or 17 Miles further from the Centre than under the Line; so that if a Removal of 16 Miles take away $\frac{125}{392}$ 4181 would take away the whole, for as 15 : 16 :: 392. 4181, without taking Notice that Attraction diminishes according to the Squares of the Distances,

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which

* *Wolffus*, Vol. III. p. 445.

which would make it reach but about 64 Miles, which is the Square Root of 4181.

The Moon therefore cannot be kept in its Orbit by any Attraction from the Earth, and yet if we consider how strong that projectile Force must be that drives so large a Body as the Moon at the rate of 2301 Mile an Hour*, how prodigious must the attractive Force be that bends that strait Projectile into an orbicular Motion?

She is so near us, that her Parallax may be, and doubtless has been accurately observed, whence her Magnitude and Distance may be known with some Certainty, her mean Distance from the Earth is $60\frac{1}{2}$ Semidiameters of the Earth, or 240000 Miles †, the Diameter of her Orbit 480,000, its Periphery 1,507,968: the Diameter of her Body ‡ 2175 Miles. She compleats her Circuit round the Earth in 27 Days, 7 Hours, and 43 Minutes, or 39343 Minutes.

We

* *Derham's Astro-Theology*, p. 18. † *Newton's Principia*, p. 430. ‡ *Derham's Astro-Theology*, p. 11.

We have a great many exact Accounts of her Transits over Planets and Fixed Stars; the former having considerable Bulk, as well as various Motions, cannot be so justly depended on as the latter, which compared with her, are Points without Motion; wherefore shall only take notice of some of the most considerable of these.

The great *Cassini* * observed the Occultation of a Star in the left hinder Foot of the Lion, which continued 56 Minutes and 54 Seconds. Another was observed † by Messieurs *Halley* and *Haines*, which lasted 56 Minutes and 52 Seconds. Another by *Hevelius* at *Dantzick* ‡, of 59 Minutes and 20 Seconds. Another of *Palilicium*, the Bull's Eye by Mr. *Gallet* ||, which continued 61 Minutes and 24 Seconds. Another by Mr. *Flamsteed* §, of 68 Minutes and 20 Seconds. And another by *Hevelius* ¶, which lasted 69
I 4 Minutes.

* *Lowthorp's Abridgm. Philos. Transact.* Vol. I. 349. † *Ejusdem*, p. 356. ‡ *Ejusdem*, p. 358. || *Ejusdem*, p. 357. § *Ejusdem*, p. 355. ¶ *Ejusdem*, p. 356.

120 *Transits of the Moon over the Fixed Stars.*

Minutes. The Difference of the Times of these Occultations may proceed from the Moon's Motion being something faster at one time than another, as she is at some times nearer the Sun by the whole Length of the Diameter of her Orbit; and that some of the Transits might not be so exactly central as others (for the Accuracy of such Observers cannot be suspected) so that we may take the Middle between the two Extrems of 57 and 69, or 63 Minutes for the exact Time of the Transit of the Moon over a Fixed Star.

The whole of her Time, in a Revolution, is as above, 39343 Minutes, or 624 times 63; so that her Orbit can be no more than so many times her Diameter, or 1.357200. wherefore her Distance from the Earth must be 216004 Miles, which is 23996 Miles less than the general Estimation.

The Æther, as was before observed *, among other Uses, is designed to regulate
and

* Page 57. of this Work.

and keep equable the Motions of all the Planets which pass through it, and is the Reason their Motions are not infinitely more swift; the Moon feels the Resistance thereof, in Proportion to its Bulk. She moves her own Diameter in 63 Minutes, at the rate of 2071 Miles an Hour, which exactly agrees to the Velocity wherewith the other Planets move through the Æther, and may be esteemed a collateral Proof of the Truth of this System.

C H A P. XXIII.

Of the Tides.

AND before we leave the Moon, it may not be amiss to consider a little the Tides, which apparently depend upon her. It is difficult to comprehend how the Moon should be able to lift up such vast Bodies of Water, as the great Seas consist of a Matter of * 16 or 18, and in some Places † 45 Foot perpendicular, tho' at the Distance of 240000 Miles, and yet the Earth, tho' many times bigger, can hardly attract a small Body of Rain from the Clouds, tho' not above two or three Miles distant.

Amber will attract Straws, fine Woodshavings, or Saw-dust, whose Force cannot be perceived on the Beam they came off. Small Particles of Iron fly up to the Magnet, which cannot move the Bar they were filed from; but the Moon can lift up to 45 Foot, Millions

* *Salmon's Universal Traveller*, Vol. II. p. 596.

† *Lowthorp's Abridgment*, Vol. II. p. 265.

Millions of Tuns of Water from the vast Ocean, which lying lower than the Land, must be nearer the Earth's Centre; yet, when by Heat or Motion its finer Parts are separated, filed or shaved off, and raised nearer to the Moon by the Weight of the Earth's Atmosphere, and so more liable to her Attraction, her Force is not able to lift them any higher; otherwise we could have no Rain on the Earth.

But were we to allow this Attraction, would that solve the double Tide in 24 Hours? Let us appeal to the common Sense of Mankind. If the Sluice at the East-end of a Pond be pulled up to let off the Water, will it make it overflow at the West? It is allowed, the Mathematicians have published some curious Diagrams to illustrate the Reason of these Tides, but it is likely more comply or rest satisfied with them, because they can devise no better, than because they are convinced of their Truth.

An ingenious *French* Author*, speaking of the Astronomy of *Aristotle* and *Ptolomy*, concludes,

* *Nature Display'd*, Vol. IV. p. 280.

concludes, that, *It is no easy Task to tell how their Epicycles could move through those thick Crusts of Crystal. They however, adds he, found Means to extricate themselves, as they always had their Recourse to geometrical Lines, which never found any Obstacle to their Passage on Paper: They foretold Eclipses, and the Returns of the Aspects, and the whole passed for true Physics.*

Whatsoever Shape the Sections of a Cone may put on, the Architect of the Universe was not obliged to work thereby. I have the highest Honour for the Mathematics, and sadly lament, that the Avocations of my Profession have prevented my making a greater Progress therein; but think with Lord Bacon*, they are proper to explain, but not to discover, or find out philosophical Truths. One may obscure and perplex plain Sense, or hide Ignorance, as well under abstracted Mathematics,

* *Novum Organum Scient.* Mathesin philosophiam naturalem terminare debet, non generare aut procreare. *Id. de Augment. Scient.* Nescio quo fato fiat ut mathematica & logica, quæ ancillarum loco erga physicam se gerere debebant; nihilominus certitudinem suam præ eâ jactantes dominatum contra exercere præsumant.

thematics, infinitesimals, conic Sections, and algebraic Equations, as the *Aristotelian* substantial Forms, Sympathies, Entelechia, and occult Qualities.

But to return to the Tides ; the accounting for whose Phænomena, has in all Ages puzzled the Philosophers, and for a long time may, unless the Diligence and Ingenuity of the Gentlemen concerned in electrical Experiments discovers the Cause that retains the Moon in its Orbit, and at the same time occasions these reciprocal Tides.

The Satellites, or Moons of Saturn and Jupiter, in all Probability, depend on the same Laws in regard to them, that our Moon does in regard to the Earth ; of this the great and sagacious *Huygens* (who had the best Means of Observation) has given some Proof in his having discovered*, that as the Moon does to the Earth, they always keep the same Side to their Primaries.

CHAP.

* *Cosmotheor.* p. 118.

C H A P. XXIV.

Of the Comets.

IN the next Place, let us consider the Comets, the Amazement and Terror of all Ages. These are very different from our Earth; there seems to be no Analogy between them, nothing that can be deduced from us to them, neither in regard to their Use or Motions; wherefore Fancy and rational Conjecture may be indulged with respect to both.

That Light is a Body, is generally allowed by Philosophers; Sir Isaac Newton says, * *Even the Rays of Light seem to be hard Bodies, for otherwise they would not retain different Properties in their different Sides.* And the ingenious Hambergerus says, † *Fire is a Congeries*

* *Optics*, page 364.

† Hamberger. *Elementa Phys.* Sect. 267. Ignis est congeries corpusculorum subtilissimorum lævissime cohærentium; ergo est corpus fluidum, & particulas habet sphaëricas, quæ figura etiam ex legibus reflexionis quas servant demonstrari potest.

geries of most subtil Corpuscles slightly coherent, is therefore a fluid Body, and has spherical Particles, which Figure may be demonstrated from the Laws of Reflection, which they observe.

So that the Sun, by incessantly emitting such Quantities thereof, must soon decay, were his Losses not somehow repaired. Body may change its Form, but can no ways be destroyed. Put a Piece of Wood, exactly weighed in a well-closed Alembic, give it what Heat you please, and for what Time; yet you are sure to have the whole of your Weight either in Water, Spirit, Oil, Salt, or *Caput Mortuum*; all the Fire on the Earth cannot destroy one Drop of Water; neither therefore can any Particle that flies off from the Sun, whether in Form of Light, Heat, or whatever else, be destroy'd; but may be so scattered and dispersed over the vast System, to need being collected and brought back for a continual Supply.

The large sweeping Tails of the Comets; that extend so many thousand Miles, are extremely well adapted for such a Purpose; and

as many of these Particles of Light and Fire may be supposed driven to a vast Distance. It is therefore necessary they should go to the outmost Limits of the System to make such a Collection.

Let us therefore suppose a Body apt for such a Purpose, detached from the Neighbourhood of the Sun, it would be light, porous and spongy; and it would be to the highest Degree so, when sent from those fiery Regions, a Body so large, so full of Pores; and so, Light would be propelled by the Violence of the Rays, and with a great Velocity to a great Distance; the further it goes, the fewer Rays strike upon it, and their Force or Velocity must be likewise supposed diminish'd. The Comet then slowly sweeps his Tail over the wide Expanse, beyond the Orb of Saturn, there, at Leisure, his Cells are filled with the Matter, it was sent out to gather up; but by and by, becoming more and more heavy, and not out of the Sphere of the Sun's Attraction;

tion ; which, upon my Principles, it is not possible it should be, as it is only driven by the Force of his Rays ; the other Scale begins to preponderate, and he slowly again to approach his Centre, his Collection increases as he descends by the other Side of his Trajectory ; that Increase adds to his Weight and Velocity, and he comes down again, if very heavy, almost in a strait Line, if less so, being more sensible of the Sun's repelling Rays in a larger Curve, till he reaches pretty near the Sun, on whom having exonerated most Part of what he had been collecting, his Pores become empty, and his Weight in equilibrio with the repelling Rays ; he moves round him in the Segment of a Circle, but growing every Moment more light, his Cellules more empty, his Weight or Quantity of Matter is no longer a Balance for the repelling Rays ; he comes again into the State when first detached, and so acts over again all its Parts, as Planets do when they have compleated their Orbits.

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And

And as it is observed, that the fixed Stars may be sometimes seen through the Tails of Comets, sometimes not *; this may be owing to their Tails being more or less replete with the Particles of Matter by them collected.

* *Wolfius*, Tom. III. p. ultima.

The CONCLUSION.

THUS having given my private Sentiments of the Sun and Planets of his System, with the Freedom that becomes a Lover of Truth, who should be according to the Motto of our illustrious Royal Society,

NULLIUS ADDICTUS JURARE IN
VERBA MAGISTRI,

I hope none will interpret the Use of that Freedom to any Fondness of Innovation, or Envy at the Fame justly acquired by Merit of any worthy Man, from whose Sentiments I may happen to differ. I have never seen any Author that pretended to account for the diurnal Rotations of the Earth and Planets. May be excused for transcribing by way of Apology, a Passage from the ingenious, the sprightly and sagacious *Voltaire*, in his Elements of Sir *Isaac Newton's* Philosophy, where speaking of these Rotations, he says, * *This Motion is not the Effect of Gravitation, it seems*

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impossible,

* Page 258.

impossible, here in particular, to have Recourse to that sufficient Reason spoken of by that great Philosopher Leibnitz, it is absolutely necessary to confess, that the Planets and the Sun might as well turn from East to West ; therefore we must allow, that this Rotation from West to East, is an Effect of the Free-will of the Creator ; and that this Free-will is the only sufficient Reason that can be assigned for it. And mine (how wild soever it may appear to Minds prejudiced in Favour of a different Philosophy) seeming to me highly probable, I thought it my indispensable Duty to publish, first, from the general Motive that has induced the Philosophers or Lovers of Wisdom in all Ages to publish their Sentiments, the Love of Truth ; and next from a Regard to my Country, which being an Island, depends greatly on its Navigation, of which every Discovery in Astronomy must be an Improvement.

Having given Reasons why the Moon cannot be supposed to be kept in her Orbit by Gravitation, nor can that be supposed the Cause of the double Tides in twenty-four Hours ; as I suppose the

true Cause of both to be Electricity; accordingly, a Theory, accounting for all the Phænomena, may be expected from me; but as no Theory, unless founded on uncontested Proofs from Experiments ought to be received; and, as I live in an obscure Country-town, far removed from Books, from Instruments, or Means to make proper Experiments, or the Conversation of any Person, sufficiently conversant in these Matters, to give me the least Assistance; must leave the Prosecution of this Affair, at least for the present, to abler Heads, and more happy Geniuses.

When the great *Galileo* first observed the Medicean Stars, he did not expect, that the Sagacity of *Roemer* * should improve that to the Discovery of the Progress of Light, or that their Eclipses would become the surest Means of discovering the Longitude, or Distances of Places. So — the Hints I have given about Electricity, may, one Day, be improved to the most useful Discovery ever made,

* *Newton's Optics*, Lib. II. Part 3. Prop. 11.

made, since the Invention of the Compass; I mean that of the Longitude at Sea. I am sensible of the Justice of *Maclaurin's* Observation, *That the Fondness of * Philosophers for their favourite Systems, often irritates them against those, who, in Pursuit of Truth, innocently overturn their Doctrines, and provokes them to catch at any Occasion of finding Fault.* The just now mentioned Reasons may entitle me to some Indulgence. I have endeavoured to draw Truth out of the Well: If my Line has been too short, or too weak, it is my Misfortune, not my Fault.

* *Account of Sir Isaac Newton's Discoveries, p. 384.*



F I N I S.

